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REPORT

OF THE

FOURTH CONGRESS

OF THE

Sanitary Institute of Great Britain

HELD AT

EXETER, SEPTEMBER 1880

BEING

VOLUME II. OF THE TRANSACTIONS

EDITORS { HENRY C. BURDETT, F.S.S.
F. DE CHAUMONT, M.D., F.R.S.

LONDON
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EDITORS' PREFACE.

THE publication of this, the second volume of the Transactions of the Sanitary Institute, has been somewhat delayed, owing to the difficulties incidental to the correction of numerous papers by authors who reside, not only in this country, but in America and elsewhere. The present volume contains several papers of interest, and important information will be found in the reports of the discussions which followed many of them. If those who desire to read papers at the next Congress will send their MS. to the Secretary of the Sanitary Institute on or before August 15, 1881, they will secure a juster consideration of the subjects in which they are interested, and will materially promote the success of the different sections.

The fourth congress of the Sanitary Institute was held at Exeter from September 21st to 26th, 1880. It may certainly be justly asserted that it was the most successful of all the meetings held since the foundation of the Institute, the genuine interest which it excited, not only in Exeter itself, but throughout the south-west district of England, was most encouraging. The Right Honourable Earl Fortescue proved a most excellent president. The Lord Bishop of Exeter, the Mayor (W. H. Ellis, Esq,), the High Sheriff, Mr. H. Stafford Northcote, M.P., and the nobility, gentry, and municipalities of Devonshire all combined to promote the success of the Sanitary Congress. The Abattoirs, which had been recently erected in one of the poorest quarters of the city, were specially prepared for the Exhibition, and the approaches to them were planted with trees and evergreens. One of them, an open space in the low

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part of the city, was converted into a garden at great expense.* By these means the situation, the character, and the sanitary surroundings of the Exhibition were happily designed to teach a lesson to the poorer inhabitants, and one of the first advantages of the Congress was to benefit directly a crowded district, the inhabitants of which were thus taught how much good could be effected by the transformation of this locality from a condition of filth and disorder to one of cleanliness and comfort. It is to be hoped that this wise action of the Corporation of Exeter will help to arouse the whole of the inhabitants to the importance and the practicability of wholesome sanitary surroundings.

The Members of the Institute were introduced to Exeter at a luncheon in the Guildhall, where the Mayor, supported by the President, the member for the City, the Sheriff and the Members of the Corporation, extended to the Congress a hearty welcome. From the Guildhall a procession, led by the Sergeant-at-Mace and the Sword-bearer, proceeded to the Abattoirs to open the Exhibition. In the evening of the same day the President delivered his address to a crowded audience at the Victoria Hall.

The business of the Congress was arranged in sections, as at Croydon, and addresses were delivered in each by the respective Presidents ;—Professor de Chaumont, M.D., F.R.S.; Mr. R. Rawlinson, C.E., C.B.; and Sir Antonio Brady. A conversazione, given by the Bishop and Mrs. Temple at the Palace, a dinner by the Mayor, W. H. Ellis, Esq. (whose untiring exertions greatly added to the success of the meeting), and a public dinner, were largely attended, and each and all of them passed off with much *éclat*. On Saturday Dr. H. C. Bartlett delivered an address to the working classes in the Victoria Hall.

At the concluding business meeting, the Right Hon. Sir Stafford Northcote, M.P., made an important speech, in which he laid stress on the relations of the Government and Parliament to sanitary reform and improvements. At this meeting the following resolutions were adopted:

(*a*.) That it is desirable to move the Privy Council to allow the days of absence from school of children suffering from infectious

* The Council have determined to maintain this garden permanently.

diseases, or in whose family infectious diseases exist, when duly testified by a registered medical practitioner, to be deducted from the statutory number of days required to qualify them for presentation for examination by the Government School Inspectors.

(*b.*) That in the opinion of this meeting the system of examination in sanitary knowledge introduced by the Sanitary Institute of Great Britain should be further extended and supported.

It was suggested that in future arrangements should be made for holding an examination during the sittings of the Congress in the towns where the meetings were held. It is hoped this idea may be carried out with success.

The sections were divided into:—I. Sanitary Science and Preventive Medicine; II. Engineering and Sanitary Construction; III. Meteorology and Geology. Each section was well attended, the papers were many of them of much practical importance, and the discussions were more animated and better sustained than at any previous meeting.

We cannot with justice withhold an expression of our feeling of indebtedness to all who assisted in making the Exeter Congress so great a success. The hearty thanks of the Institute are due to the Bishop, the Mayor and Corporation, the Sheriff, and the citizens generally for the cordial welcome they extended to their visitors. Nothing could exceed the kindness and hospitality which one and all experienced, and no words can adequately express the general feeling of gratification and pleasure which the remembrance of this visit to Exeter will always recall to the minds of everyone who took part in the Congress.

The Local Honorary Secretaries, Messrs. Domville and Boulnois, deserve high praise for the admirable manner in which their really arduous duties were performed. Finally, the usefulness of the Congress was greatly extended and promoted by the full and excellent reports which the whole of the local and many of the metropolitan papers gave of the proceedings. In this connection we may be allowed to add that the Registrar, Mr. G. J. Symons, F.R.S., rendered material service by his untiring industry, powers of organisation, and ready appreciation of the various matters which called for his unceasing attention throughout the meeting; and to him belongs the credit of much of the success to which we have already referred.

Once again it is necessary that we should state that the fact of a paper being printed does not commit the Council, the Editors, any individual member (except the author), or the Sanitary Institute collectively, to the views therein expressed. For all such opinions the author of each paper is alone responsible.

*** It will be noticed that the Calendar is not included in the present volume. For the future it will be published separately at the commencement of each year.

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LIST OF AUTHORS AND CONTRIBUTORS.

Agnew, Thomas.
Bartlett, H. C.
Boulnois, H. Percy.
Brady, Sir Antonio.
Burdett, Henry C.
Chadwick, Edwin.
De Chaumont, Dr. Francis S. B. F.
Decroix, M.
Domenichetti, Dr. R.
Fortescue, Earl.
Foster, George A.
Grantham, R. B.
Jones, Lieutenant-Colonel Alfred E.
Lake, W. C., Dr.
Lee, Richard, junr.
Nourse, W. E. C.
Perkins, Frank P.
Rawlinson, Robert.
Richardson, Dr. B. W.
Scott, Major-General H. Y. D.
Slade-King, Dr. Edwyn.
Stephenson, F. C.
Symons, G. J.
Waring, Colonel G. E.
White, William.
Woodman, John.
Woodman, Dr. W. R.

THE SANITARY INSTITUTE OF GREAT BRITAIN.

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HIS GRACE THE DUKE OF NORTHUMBERLAND.

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EDWIN CHADWICK, C.B.

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SECRETARY.

MR. E. WHITE WALLIS, F.M.S.

OFFICES.

9 CONDUIT STREET, REGENT STREET, LONDON, W.

OBJECTS OF THE INSTITUTE.

To devote itself to the advancement of Sanitary Science and the diffusion of knowledge relating thereto.

To examine and to grant Certificates of Competence to Local Surveyors, to Inspectors of Nuisances, and to persons desirous of becoming such or of obtaining the Certificate. The Examinations shall be held at such times and places as the Council may direct.

A Board of Examiners shall be appointed by the Council; such Board shall consist of gentlemen representing Medical, Chemical, and Sanitary Science, Engineering, Architecture, and Sanitary Jurisprudence.

The Examination for Local Surveyors shall include a competent knowledge of the Statutes relating to Sanitary Authorities, of Sanitary Science and Construction, and of Engineering.

The Examination for Inspectors of Nuisances shall comprise the elements of Sanitary Science, together with Sanitary Construction, and the Statutes relating to the prevention of disease and the suppression of nuisances injurious to health.

Fees shall be charged for the Examinations, and a Certificate of Competence, signed by the Examiners, shall be granted to successful candidates, entitling them to be designated as "Certificated by the Sanitary Institute of Great Britain."

The Institute shall take such steps as may be within its power to obtain a complete registration of sickness, especially of preventable diseases.

The Institute shall endeavour to secure the services of medical men and others specially qualified to give lectures on subjects relating to the prevention and spread of disease.

The Institute shall encourage the formation of classes for technical instruction in Sanitary Science in such a way as may seem advisable to the Council.

Exhibitions of Sanitary Apparatus and Appliances shall be held from time to time as the Council may direct.

Fellows, Members, Associates, and Subscribers shall have the right of Free Admission to the Exhibitions of the Institute whenever they are open. All fees payable by Exhibitors and the Public shall be fixed by the Council and belong to the Institute.

A Catalogue shall be published under the direction of the Council as a permanent record of the Exhibitions.

A Library shall be formed in connection with the Institute.

A Congress shall be held by the Institute for the consideration of subjects relating to Hygiene at such times and places as the Council may direct.

PAPERS AND DISCUSSIONS.

Authors are reminded that the acceptance of Papers, and the days on which they are to be read, are as far as possible determined by the Council before the beginning of each Congress. The Council reserve the right of refusing any Papers sent in; and in the case of those accepted, the reading of them must depend upon the time at the disposal of the Council. No previously published Paper can be read. Papers read at the Congress cannot be published by the Authors, except by permission of the Council. The Council reserve to themselves the privilege of printing any Paper read at the Congress, either wholly or in part; or of refraining from the publication thereof, if they see fit. Papers are limited to twenty minutes in reading, and the discussion upon them to ten minutes for each speaker. In order to give an opportunity to the Council of doing justice to the several communications, and to assist the Editors of the Transactions, each Author should prepare an abstract of his Paper and send it, together with the original manuscript, by book-post, *on or before August* 15 in each year, addressed to the Secretary, Sanitary Institute of Great Britain, 9, Conduit Street, Regent Street, London, W.

Authors whose Papers have been received and accepted will be furnished with printed copies before the commencement of the Congress.

CONGRESSES AND OFFICERS.

TABLE showing the places at which the Congresses of the Sanitary Institute of Great Britain have been held; with Presidents, Presidents of Sections, and Local Honorary Secretaries and Treasurers.

PRESIDENTS.	PRESIDENTS OF SECTIONS.	LOCAL HONORARY SECRETARIES AND TREASURERS.
1877.—B. W. RICHARDSON, LL.D., M.D., F.R.S., **Leamington**, October.	EDWIN CHADWICK, C.B. GEORGE WILSON, M.D., M.A., F.C.S. BRUDENELL CARTER, F.R.C.S.	JAS. THOMPSON, M.D. JOSEPH S. BALY, F.C.S. T. H. THORNE, J.P.
1878.—EDWIN CHADWICK, C.B., **Stafford**, October.	B. W. RICHARDSON, M.D., LL.D., F.R.S. HENRY DAY, M.D., F.R.C.P.	WM. ELLIS CLENDINNEN. H. B. LIVINGSTON. THOMAS WOOD.
1879.—B. W. RICHARDSON, LL.D., M.D., F.R.S., **Croydon**, October.	ALFRED CARPENTER, M.D., C.S.S. Camb. CAPTAIN DOUGLAS GALTON, R.E., C.B., F.R.S. G. J. SYMONS, F.R.S.	H. J. STRONG, M.D. ROBERT HALL. SAMUEL LEE RYMER.
1880.—THE RIGHT HON. EARL FORTESCUE, **Exeter**, September.	PROFESSOR DE CHAUMONT, M.D., F.R.S. R. RAWLINSON, ESQ., C.E., C.B. SIR ANTONIO BRADY.	E. J. DOMVILLE, M.R.C.S.E. H. P. BOULNOIS, M. INST. C.E. W. G ROGERS.

EXETER CONGRESS.

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RIGHT HON. LORD POLTIMORE
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JOHN DAW, Exeter.
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D. W. R. BUCHANAN, Chairman of Torquay Local Board.
JOSHUA DIXON, J.P., Winslade.
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J. C. BOWRING, J.P., Windsor.
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T. CAREW, J.P., Tiverton.
J. FLEMING, J.P., Bigadon.
MAJOR-GENERAL PHILLIPPS TREBY, J.P., Plympton.
G. C. DAVIE, J.P., South Tawton.
REV. TREASURER HAWKER, Berrynarbor.
LIEUT.-COL. WHITE-THOMSON, J.P., Exbourne.
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REV. W. D. PITMAN, Aveton Gifford.
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HENRY WOOLLCOMBE, J.P., Ashbury.
J. WOOD, J.P., Exmouth.

SANITARY INSTITUTE OF GREAT BRITAIN.

FORMATION OF THE INSTITUTE.

THE increasing importance attached to Sanitary Science, and the recognized position it is assuming in the public mind, appeared to the promoters of the Sanitary Institute fully to justify the formation of a National Society, the object of which should be to devote itself *exclusively* to the advancement of all subjects bearing upon Public Health. In furtherance of the object, a meeting was held at St. James's Hall, on the 13th July, 1876, at which His Grace the Duke of Northumberland presided, when it was unanimously resolved :—

First—'That in the opinion of this meeting the Sanitary condition of this country is still very unsatisfactory and that further legislation is necessary with a view to its improvement; and that for the purpose of collecting and imparting information upon all matters connected with the subject of "Public Health," a Society be now formed to be styled "The Sanitary Institute of Great Britain."'

Second—'That the gentlemen whose names are appended be requested to act as a Committee (with power to add to their number) for the purpose of carrying out the previous resolution and of reporting to an adjourned public meeting to be held in the second week in October next.'

An adjourned public meeting was held on the 14th of March, 1877, when the report was unanimously adopted, and a Council subsequently appointed to carry it into effect.

The Committee appointed to report upon the subject considered it would add greatly to the usefulness of the Institute if Mayors of Boroughs, Chairmen of Local Boards, Sanitary Authorities, Medical Officers of Health, and all who have to administer the Public Health Acts, would associate themselves with the Institute, either in their individual or corporate capacity, and take part in its proceedings. By thus bringing their united knowledge and experience to bear upon Sanitary matters, the Laws relating to the same would become better known and be more efficiently administered.

Basis of the Constitution of the Institute.

Section I.

Charter of Incorporation, Membership, and Government of the Institute.

As soon as practicable a Charter of Incorporation shall be obtained, as it will facilitate some portions of the work of the Institute, more especially the examinations set forth in Section II. Until a Charter is obtained, the examinations shall be continued as heretofore, and a Register of persons certificated as competent to act as Local Surveyors and Inspectors of Nuisances shall be formed.

The Institute shall consist of Fellows, Members, Associates, and Subscribers.

Fellows shall be elected by ballot by the Council, and shall include scientific men of eminence, persons of distinction as Legislators or Administrators, and others who have done noteworthy Sanitary work.

All Fellows (except those who have already become Life Members) shall pay a fee of Ten Guineas on taking up the Fellowship, and such fee shall entitle the Fellow to all the privileges and advantages of the Institute for life without further payment.

Any person proposed by five Fellows or Members, shall be eligible for election as a member of the Institute.

Members shall be elected by ballot by the Council, and shall be eligible to serve on the Council, and to vote at all elections and Meetings of the Institute. The Admission Fee payable by a Member shall be £3 3*s*., and the Annual Subscription £2 2*s*.

Medical Officers of Health and Medical Men holding Certificates in Sanitary Science from any University or Medical Corporation shall be entitled to be enrolled as Members of the Institute without Admission Fee.

Members desirous of becoming Life Members may do so on payment of £10 10*s*. in lieu of the Annual Subscription.

All persons who have passed the Examination and received the Certificate for Local Surveyor from the Institute, shall, by virtue of having so passed, become Members of the Institute upon the payment of Five Guineas (without Annual Subscription) in addition to the fee paid for the Examination and Certificate.

Any one proposed by two persons, either Fellows, Members, or Associates of the Institute shall be eligible to be elected as an Associate of the Institute, the election to be by ballot by the Council. The Admission Fee payable by Associates shall be Two Guineas, and the Annual Subscription One Guinea.

All persons who have passed the Examination and received the Certificate for Inspector of Nuisances from the Institute, shall, by virtue of having so passed, become Associates of the Institute upon payment of Three Guineas (without Annual Subscription) in addition to the fee paid for the Examination and Certificate.

Persons of either sex, interested in the advancement of Sanitary Science, shall be entitled to be enrolled as Subscribers on payment of One Guinea annually. Annual Subscribers shall be entitled to attend and to take part in the discussion at all Meetings and Congresses of the Institute, and shall have free admission to the Conversaziones and Exhibitions of Sanitary appliances held in connection with the Institute, so long as they continue to pay their Subscription.

Donors of Ten Guineas and upwards shall be entitled to be enrolled as 'Life Subscribers,' with all the privileges and advantages of Annual Subscribers without further payment.

Subscribers of Half-a-Guinea to any Congress of the Institute shall be entitled to a card of admission to the Meetings, Addresses, Conversazione, Excursions, and Exhibition held in connection with that Congress.

The Institute shall be governed by a President, Vice-Presidents, and a Council of Twenty-four, consisting of Fellows and Members of the Institute, of whom not less than two-thirds shall be Fellows. The Council shall be chosen by the Fellows and Members. One-fourth of the Council shall retire annually, and shall not be eligible for re-election for one year.

The first President of the Institute shall be His Grace the Duke of Northumberland. Future Presidents and Vice-Presidents shall be elected by the Council. The Council shall have the power of electing Honorary Members of the Institute, Honorary Foreign Associates, and Corresponding Members of the Council.

Examination of Local Surveyors and Inspectors of Nuisances.

The great and increasing importance of the duties devolving upon Local Surveyors and Inspectors of Nuisances, in connection with the various statutes relating to public health, and the Sale of Food and Drugs Acts, has led the Council of the Institute to establish voluntary examinations for Local Surveyors and Inspectors of Nuisances, and for persons desirous of becoming such or of obtaining the certificate of the Institute.

Each examination occupies a portion of two days. On the first day the examination of surveyors is continued for four hours, viz., from 2 to 4, and 6 to 8 p.m., and consists of written papers only. Inspectors of Nuisances have two hours' written examination on the first day, viz., from 4 to 6 p.m. On the second day the examination, for both classes, commences at 11 a.m., and is *vivâ voce*, with one or more questions to be answered in writing *if deemed necessary*. A Certificate of Competence, signed by the examiners, is granted to successful candidates.

As rural sanitary authorities are able under the Public Health Act, 1875, to obtain almost all the powers of urban sanitary authorities, it is not considered advisable to make any distinction in the examination of the two classes of surveyors.

As one person may, under the Public Health Act, 1875, be both Local Surveyor and Inspector of Nuisances, candidates wishing to obtain the double qualification may enter for both examinations on the same occasion.

Candidates are required to furnish to the Council of the Institute satisfactory testimonials as to personal character, and to give two weeks' notice to the Secretary previous to presenting themselves for examination, stating whether they wish to be examined as Surveyors, as Inspectors of Nuisances, or as both. The fee for the examination must be paid to the Secretary, by Post Office order or otherwise, at least six days before the day of examination. On receipt of the fee, a ticket will be forwarded admitting to the examination.

The fees payable for the examination are as follows :—

For Surveyors	£5 5*s.*
For Inspectors of Nuisances . - .	£2 2*s.*

Unsuccessful candidates are allowed to present themselves a second time for one fee. Examinations during the year 1881 are appointed to be held :—

On Tuesday and Wednesday, June 2nd and 3rd.

On Thursday and Friday, November 3rd and 4th.

Forms to be filled up by candidates previous to examination will be supplied on application to the Secretary, 20 Spring Gardens, London.

BOARD OF EXAMINERS.

H. C. Bartlett, Esq., ph.d., f.c.s.

Alfred Carpenter, m.d., lond., s.sc.certif., camb.

Professor F. S. B. F. de Chaumont, m.d., f.r.s., Army Medical School, Netley.

Professor W. H. Corfield, m.a., m.d., oxon., f.r.c.p., University College.

W. Eassie, Esq., c.e., f.l.s.

Rogers Field, Esq., b.a., mem. inst. c.e.

Captain Douglas Galton, r.e., c.b., f.r.s.

W. H. Michael, Esq., q.c., f.c.s.

Ernest Turner, Esq., f.r.i.b.a.

SYLLABUS OF SUBJECTS for EXAMINATION.

FOR LOCAL SURVEYORS.

Laws and Bye-Laws—A thorough knowledge of the Acts affecting Sanitary Authorities so far as they relate to the duties of Local Surveyors; also, of the Model Bye-Laws issued by the Local Government Board.

Sewerage and Drainage—The Sanitary principles which should be observed in the preparation of schemes for, and the construction of, Sewerage Works; the ventilating and flushing of Sewers and Drains; the internal Drainage and other Sanitary arrangements of Houses, Privies, Water-closets, Dry-closets, and the removal of refuse; the Sanitary details of Builders' and Plumbers' Work.

Water Supply of Towns and Houses—The Sanitary principles which should be observed in the preparation of schemes for, and the construction of, Waterworks; the various ways in which water is likely to become polluted, and the best means of ensuring its purity.

Regulations of Cellar Dwellings and Lodging Houses—General principles of Ventilation; the amount of air and space necessary for men and animals; the means of supplying air, and of ensuring its purity.

Highways and Streets—The Sanitary principles which should be observed in the construction and cleansing of Streets and Roads.

FOR INSPECTORS OF NUISANCES.

A thorough knowledge of the provisions of the Acts and Model Bye-Laws relating to the duties of Inspectors of Nuisances; also of the working of the Sale of Food and Drugs Act.

A fair knowledge of the Principles of Ventilation, and of simple Methods of Ventilating Rooms—Measurement of Cubic Space.

A knowledge of the Physical Characters of good Drinking Water—the various ways in which it may be polluted, and the means of preventing pollution—Methods of Water Supply.

A knowledge of the proper conditions of good Drainage.

The advantages and disadvantages of various Sanitary Appliances for Houses—Inspection of Builders' and Plumbers' Work.

A knowledge of what constitutes a Nuisance arising from any Trade, Business, and Manufacture.

A fair knowledge of the characteristics of good and bad Food (such as Meat, Fish, Milk, Vegetables), so as to be able to recognise unsoundness.

Some knowledge of Infectious Diseases, and of the Regulations affecting persons suffering or recovering from such diseases.

A knowledge of the best Methods of Disinfection.

Methods of Inspection, not only of Dwellings, Dairies, Milk Shops, but of Markets, Slaughter-houses, Cowsheds, Bakehouses, and Offensive Trades.

Scavenging and Disposal of Sewage.

EXAMINATION PAPERS, 1880.

The following questions were required to be answered in writing. A *vivâ voce* examination took place on the following day.

JUNE 1 AND 2.

QUESTIONS FOR SURVEYORS.

2 TO 4 P.M.; AND

INSPECTORS OF NUISANCES.

4 TO 6 P.M.

Those questions marked 'I.N.' are for Inspectors of Nuisances only.

1. In arranging the water supply for a manufacturing town of 30,000 inhabitants, state what you consider of importance—
   (*a*) As to sources of supply.
   (*b*) Quantity required.
   (*c*) Distribution.
   (*d*) Compensation.
2. What dangers are there to be apprehended to a public water supply in a town sewered, and with the water supply intermittent? How should these dangers be provided against and remedied?
   (*a*) Within the house.
   (*b*) Without the house.
3. What is meant by horse-power?
4. What quantity of water would a steam-engine of 12 horse-power (effective) raise fifty feet high in twelve hours? What would it cost per annum to work such an engine, coals being 12*s.* per ton, under the above conditions working a week?

I.N. 5. What are the dangers to be apprehended from a water supply in any district which is supplied by wells?

I.N. 6. What is required in the way of ventilation to keep a room with an air space of 1,000 cubic feet in a proper sanitary condition, there being a gaslight burning in the room 6 feet from the floor, and consuming 4 feet of gas per hour? Sketch your plan, and reasons for its employment.

I.N. 7. Explain the difference of the conditions as to warming which prevail in a room heated by an open fire and in a room heated by fresh warm air introduced by flues, the temperature of the air in the room being assumed to be the same in each case.

I.N. 8. You are appointed to the post of Inspector of Nuisances. What are the duties you would at once undertake in your district?
   (*a*) With regard to inspection of common lodging-houses.
   (*b*) With regard to nuisances.
   (*c*) With respect to wholesome food.

9. Describe the following processes for dealing with water-carried sewage of towns—
   1. By irrigation.
   2. By chemical deposition.
10. Describe the different methods of forming storm overflows in sewers.
11. Describe in detail the arrangements you would adopt to prevent deposit from road drift accumulating in sewers.
12. When junctions occur in sewers, what should be the level of the invert of the junction sewer as compared with that of the main sewer?

I.N. 13. What is the effect on the air of the room of heating a room by means of an open fire as compared with warming it by means of hot-water pipes at a low temperature?

14. In a square room, with the four walls exposed to the atmosphere, what is the proportionate loss of heat through the walls if built solid, and that through the walls of similar total thickness, but built with a closed air-space in the centre? What is the rule which governs the loss of heat?

I.N. 15. You are sent for to a house where two children died the day previously of scarlet fever: what steps would you take?
   (*a*) Where a house has a drain into the public sewer.
   (*b*) When undrained.
   (*c*) As to disinfection of clothing.

QUESTIONS FOR SURVEYORS.

6 TO 8 P.M.

1. How is the water supply of a town regulated by existing legislation?
   (*a*) Where there is no company existing.
   (*b*) Where there is a company without statutory powers.
   (*c*) Where there is a company with statutory powers.
2. How does the present general public health legislation affect the metropolis?
3. There is a complaint in a given neighbourhood that a certain sewer smells. What are the steps to be taken (1) to find out the cause if any? (2) to remedy the same? Illustrate your answer by a sketch.
4. Will you explain what is meant by disconnecting a house drain from the sewer, and what adjuncts are necessary, and what in the matter of ventilation? Give a sketch of any two disconnecting arrangements which you are acquainted with.
5. Where a town is situated on a side of a hill, describe the arrangements you would adopt to prevent the lower districts being flooded, or the upper districts being injured by gases generated in the sewers.

6. Describe the following processes for purifying sewage :—

   The lime process.
   The A B C „
   The irrigation of land.

   Explain the mode of action in each case.
7. State what is the degree of impurity of the effluent, and what are the conditions under which it may be allowed to flow into a stream.

QUESTIONS FOR EXAMINATION, NOVEMBER 4 and 5, 1880.

SURVEYORS.

First Paper.

1. What difference exists between urban and rural sanitary authorities?

   (1st) As to roads, streets, and buildings.
   (2nd) As to sewers.
   (3rd) As to gas and water supply.

2. What are the chief causes of the formation of foul air in sewers? How can its production be prevented?

   (*a*) In new sewers.
   (*b*) In old sewers.

3. In laying out a system of sewers for a town, should you lay the sewers in curves or straight lines? Give your reasons, and illustrate your answer by a sketch. Also state under what circumstances you would consider it advisable to make a sewer large enough for a man to pass along it.
4. Describe shortly the different methods of applying sewage to land, and in each case explain the conditions under which you would adopt it.
5 In what way does the size and shape of a sewer affect the velocity of the sewage flowing through it? If a 12-inch pipe sewer, with an inclination of 1 in 200, gives a velocity of $3\frac{1}{2}$ feet per second, what velocity would it give if laid at an inclination of 1 in 800 (the pipe running half full in each case), and would this latter velocity suffice to keep the sewer clear of deposit? To what extent could this velocity be practically increased by flushing?
6. What precautions should be taken, in connecting houses with sewers, in order to prevent foul air from the sewers entering the houses? What kinds of connections would you require for the water closets, sinks, &c.?

SURVEYORS.

Second Paper.

1. What is the essential difference between an artesian and an ordinary well? Describe the ways in which the water in each of these is liable to pollution, and state how such pollution is preventable.
2. In what ways is water liable to be polluted after collection, during its distribution to houses, and in the houses? What means would you adopt to prevent such pollution?
3. Explain the action of the hydraulic ram, and give a sketch. A stream, with a fall of 6 feet, and giving 50 gallons per minute, is used to work a ram; state approximately how much water it will pump in 24 hours to a height of 72 feet.
4. Given two sleeping rooms, one 10 feet by 15 feet and 10 feet high, the other 15 feet by 20 feet and 12 feet high, with three adults in each—how much fresh air would you supply, and in what way, in each case?
5. What are the sanitary advantages and disadvantages of the modern systems of street and road making? Give a brief description of each.

INSPECTORS OF NUISANCES.

1. What is a cellar dwelling? Under what conditions may underground rooms be inhabited?
2. How do you ascertain whether a room is overcrowded or not? What proceedings do you take in case of overcrowding?
3. What is the definition of a nuisance under the Public Health Acts?
4. What are the characteristics of good butcher's meat? How do you recognise the various conditions of meat unfit for human food?
5. How would you disinfect a room and the things in it after a case of scarlet fever? In what cases can you insist on the removal of the infected person to a hospital?
6. In inspecting a house, after a case of typhoid fever, to what points would you particularly direct your attention?

CANDIDATES WHO HAVE RECEIVED CERTIFICATES AS LOCAL SURVEYORS.

1880, Nov. 5, Boulnois, H. Percy, M. Inst. C.E., Exeter.
,, Burton, W. Kinninmond, John Street, Adelphi.
1879, June 4, Cameron, D., Exeter.
1880, June 2, Clare, J.
1878, June 5, Gamble, S. G., Grantham.
1878, Nov. 7, Harger, R., Skipton.
1880, Nov. 5, Harland, A., High Barnet.
,, Innes, Cosmo, M. Inst. C.E., John Street, Adelphi.
1878, June 5, Jenkins, W. J. P., Bodmin.
1880, June 2, Nichols, H. B., Handsworth.
1877, Oct. 29, Parker, J., Bridgewater.
,, Robinson, H. W., Ulverston.
1879, June 4, Trouzeau, E. R., New Brighton.

CANDIDATES WHO HAVE RECEIVED CERTIFICATES AS INSPECTORS OF NUISANCES.

1877, Oct. 29, Blanchard, T., Evesham.
1879, Nov. 7, Bolt, B., Aston, Birmingham.
1877, Oct. 29, Booker, F., Birmingham.
1878, Nov. 7, Chubb, T. T., Whitchurch.
1880, June 2, Clare, J.
1879, Nov. 7, Clarke, A. Lennox, Bedford.
1878, June 5, Dale, T. H., Hastings.
1878, Nov. 7, Davies, H., Wrexham.
1878, Feb. 7, Gander, C., Alcester.
1880, Nov. 5, Harland, A., High Barnet.
1878, Nov. 7, Harris, W., Solihull, Warwick.
1878, June 5, Hawkes, C., Yeovil.
1879, Nov. 7, Lapworth, J., Bethnal Green.
,, Osborne, J., Carlisle.
1877, Oct. 29, Prebble, W. S., Blackburn.
1878, Feb. 7, Robinson, J., Birmingham.
,, Watts, W. F., Amersham.
,, Wetherill, W., Selby.
,, Wilkinson, W., Salford.

PRESIDENT'S ADDRESS.

ADDRESS

BY

EARL FORTESCUE,

President of the Congress.

I CONCLUDE that my election to the honourable post to which the favour of the Sanitary Institute has called me is due to my being the only Devonshire man very long publicly identified with the great sanitary cause, though I have been so by the efforts and sacrifices which I have made for it, rather than by any signal services which I have been ever able to render to it. My connection, however, with that cause is now of old date. After reading that most remarkable report made by my valued friend Mr. Chadwick, in 1842 (which, as was well observed by my old schoolfellow, Dr. Acland, in his Address to the British Medical Association the other day, 'may be taken as the foundation of all complete modern sanitary work in this country'), I selected the Health of Towns as my subject for the lecture which I had promised to deliver to my constituents at Plymouth in 1845; and from that time to this my interest in that great cause has remained unabated.

On looking back at those days after the lapse of a whole generation, I must allow that, relying on the soundness of our views and the accumulated evidence on which they were based, we early sanitary reformers somewhat underrated the strength of the opposition we had to encounter. Ignorance, prejudice, vague alarm, and real or imagined self-interest arrayed against us a formidable body, comprising not only the mass of the wage class, for whose benefit, as the greatest sufferers from the then general violation of the plainest laws of hygiene, the efforts made for their enforcement were more especially directed, but comprising also too many who ought to have known better. I remember when 'the poor man's pig' was a most potent election cry in various borough contests, and it was difficult to say whether the pigkeepers themselves or their non-pigkeeping next-door neighbours suffered most from the close proximity of the animal, or were most indignant at the idea of his compulsory removal. I recollect, at the same time, that Mr. Bright, and many other well-known politicians of both parties, opposed sanitary reform; as did pretty generally the municipal authorities throughout the country, and also, most vehemently, the vestrymen of the metropolis. Still the facts and arguments adduced in Mr. Chadwick's report—fully confirmed afterwards in every particular, and only expanded in the series of able reports from the Health of Towns Commissioners, under the presidency of the Duke of Buccleuch—appealed so powerfully to sound economy as well as to humanity, that though the subject was not a congenial one for mob oratory, they quickly produced a deep impression upon the more enlightened and benevolent part of the community, and upon none a deeper impression than upon my two truly noble friends, Lord Carlisle and Lord Shaftesbury. Lord Carlisle—now long since removed to a better world—became, as Lord Morpeth, a member of the Government formed by Lord John Russell on Sir Robert Peel's resignation in 1846. Lord Shaftesbury, who is happily still spared to labour for the benefit of his fellow creatures, had been then already engaged for years in endeavouring to get the health and lives of workers in factories generally protected from the dangers of unguarded machinery, and the children especially from destructive overwork. He therefore readily joined the band of early sanitary reformers in their kindred task. Among these, Dr. Southwood Smith, as a scientific man, had taken a prominent part. Bishop Blomfield, also clearly discerning the important bearing of sanitary reform upon decency and morality, and consequently upon religion, gave it the benefit of his influential support in the House of Lords and elsewhere.

I intend treating sanitary reform in this country, both as regards the past and the future, rather in its administrative and legislative than in its various other aspects, because very many here assembled are much more competent to treat it in all of them than myself; while

I have now sat for nearly forty years in Parliament, during a few of which I had experience both of salaried and unsalaried office.

I have said that the official reports mentioned had produced a deep impression on the more enlightened and benevolent members of the community. This impression was greatly increased and widely diffused by the circulation of their substance through the country, sometimes by speeches and lectures, sometimes in tracts issued by the Metropolitan Sanitary Association, whose foundation, under most influential auspices about that time, was itself a proof of the growing importance attached to sanitary reform. But no distinct sanitary legislation or administration had as yet been even definitely proposed. For the quarantine regulations, which had long been established by us as well as all other civilised nations, practically much more to the detriment of commerce and the inconvenience of travellers than to the efficient protection of the people from epidemics, hardly deserve to be considered an exception to this statement; nor even (though it was a decided step in advance) does the passing of the first Vaccination Act in 1840.

It was Lord Morpeth to whom belongs the honour, as a member of Lord John Russell's Government, of making the first great move in sanitary reform, by superseding and consolidating into one the seven metropolitan Commissions of Sewers, which had hitherto managed, or rather, with the honourable exception of the Holborn Commission, grossly mismanaged the sewerage of the metropolis. In estimating the importance of this great move it should be remembered that London surpassed the whole of Scotland in population, and probably both Scotland and Ireland together in wealth; that, besides being the wealthiest and most populous city on the face of the globe, it was the seat of government and the centre of business of an empire on which the sun never sets; and that the consequent influence of its example for good or evil, not only in the United Kingdom, but throughout the Empire and indeed the civilised world, must be immense.

The seven Commissions of Sewers comprised hundreds of members headed by most illustrious names, such as the Duke of Wellington's and the Lord Chief Justice's, who, it is needless to say, never attended, if, indeed, they were ever aware of their ædile dignity. But the Commissions included also builders and plumbers, and too many others, very diligent in their attendance, whose ignorance of the first principles of sanitary engineering was only equalled by their complete mastery of the art of jobbing. A few public-spirited vestrymen had latterly been exposing the incompetence and jobbery of the Westminster Commission, and had thus helped to prepare the public mind for Lord Morpeth's stroke. He in one day revoked all the seven Commissions and issued seven identical fresh ones to a limited number of persons, either already to a certain degree conversant with the subject, or ready to take a practical interest in it, including himself, Mr. Chadwick, and your humble servant. He thus virtually established, under the old statutes, a consolidated Commission of Sewers for the whole metropolis, which at once gave the inhabitants the benefit of a far more efficient consolidated staff than the seven separate ones under the seven Commissions, at less cost even in salaries, and very much less if perquisites were taken into account. The next year he carried a new Metropolitan Sewers Act, cumbrous indeed to work, but providing unity of administration under a new and still smaller body of Commissioners, equally Crown-appointed and equally unpaid, who did me the honour of electing me their Chairman. It comprised various eminent civil and military engineers, such as, for instance, Mr. Robert Stephenson and Mr. Rendel, Sir J. Burgoyne and Sir H. De la Beche, and others from other professions, including two or three from the City of London. We worked very hard for several years; but we could not do much, for we had found no reliable map even of the surface, much less any reliable plan of the sewers underground. However, by getting maps and plans made, we prepared the materials for dealing comprehensively with the sewerage of the whole metropolis; and we meanwhile greatly improved the sanitary condition of many of the slums and several of the streets, wherever we were able to do so with works capable of adaptation to any scheme of main drainage hereafter to be undertaken. These works comprised a constant supply of clean water under pressure, by arrangement with the Water Companies, and a constant removal of the fouled water or sewage by self-cleansing house-drains and sewers generally carried by the backs instead of the fronts of the houses; and they on trial fully verified the soundness of our principles and their general applicability on any scale, large or small. These works, moreover, were actually completed for less than one-third of the cost of such works under the previous system of sewers and drains of deposit, where any were provided at all, which in the poorer neighbourhoods was the rare exception instead of the rule; for we substituted 4-inch glazed pipes for the former nearly flat-bottomed man-size brick house-drains, with corresponding reductions of dimensions and cost in the alley and street sewers. We were latterly, indeed, ill-supported by the Government, which was more and more pressed by our opponents in the Metropolitan vestries and their representatives. Many of us in consequence resigned, and a new Commission was appointed; but that, not long afterwards, was superseded by the Board elected under the Metropolitan Local Management Act of 1854, brought in by Sir B. Hall, the especial representative in Parliament of the Marylebone and St. Pancras Vestries, both notoriously most hostile to the Commission.

Of that important, but in my opinion, most defective statute, and its operation, and of the Metropolitan Board of Works which it established, I shall have something to say hereafter. I must now return to the general sanitary legislation for the whole country.

In 1848, Lord Morpeth, chiefly by his intense earnestness combined with almost unmatched sweetness of temper, carried, with little alteration, the Public Health Act, the first, and I think in some respects, the best sanitary statute ever passed for the whole kingdom; a measure in the introduction of which he did me the great honour of associating my name with his own and Sir G. Grey's. That Act established the first General Board of Health, whose official publications have been of inestimable service to the cause of sanitary reform throughout the world. It also embodied certain provisions, a subsequent departure from which has been in my view mistaken and retrograde.

The constitution of that Board of Health gave every promise of utility. The three working members of it—and they were emphatically workers—were Lord Shaftesbury (then Lord Ashley), Mr. Chadwick, and Dr. Southwood Smith. Lord Ashley gave it as much time and attention as his various other religious and philanthropic labours would allow. Indeed, I know that he considered his work there of primary importance. Mr. Chadwick for years devoted almost the whole of his indefatigable energy and great ability to the work of the office; not merely to the duty of administration, but also to the collection of sanitary information from all quarters, and its re-issue to the public, tested, digested, and prepared for practical application. These two were efficiently aided by Dr. Southwood Smith, who to high professional qualifications added the gift of singularly clear and pleasing exposition; and these efforts were well seconded by several zealous and able subordinates. The first Superintending Engineer Inspectors appointed under the Public Health Act of 1848 were—Mr. Cresey, Mr. Clark, Mr. Rawlinson, and Mr. Ranger, who were severally selected and appointed for their known practical knowledge. The first town reported upon was Dover, Mr. Rawlinson having made there the first inquiry and report.

The Board's official publications embraced, not merely detailed separate reports on many provincial towns, with separate schemes for their drainage and water supply, but also reports on various important Metropolitan questions and the best and most economical modes of dealing with them; such as interments, water supply, and sewerage. And the adoption of these reports, if it had not unfortunately been prevented by the ignorance and apathy of successive Governments and Parliaments and the active opposition of interested parties, would not only have saved millions to the inhabitants of London, since pocketed by trading Water and Cemetery Companies, but would also have added immensely to the wealth, comfort, and security of all classes, and especially the most numerous of all, the wage class; who are, at least, equally exposed with the rest to danger from fire, and, far more than any other, to the ravages of infection. How cheap would it have been to have bought the Water Companies' works, as recommended by the Board thirty-nine years ago, even if they had been paid ten per cent., instead of the average five per cent. which they were then receiving on their capital expended of about 6,000,000*l.*! How many lives, to say nothing of property, would have been saved in London if there had been, as at Manchester, hydrants everywhere, enabling water to be thrown on each fire as it broke out, in one-third less time on the average than by the best managed and speediest fire-engines! How much more of temperance might there not have been if, instead of water from a foul cistern, often with an iridescent scum repulsive to the thirstiest, every inhabitant could at any hour have drawn, from a tap in the house, water clear and pure straight from the main!

The Metropolitan Local Management Act established a representative body to deal with the large but urgent question of the sewerage of the metropolis. It did so on the basis of the old Vestry Act;

and the result was exactly what I predicted in the House of Commons during the discussion of the Bill.

The new Board, for the chairmanship of which I was vainly pressed by Lord Palmerston's Cabinet to become a candidate, proceeded to construct as soon as their engineer, Mr. Bazalgette, had completed the designs for them, the gigantic intercepting sewers for rainfall as well as sewage, with pumping engines and outfalls near Barking; enormously costly, and as unsatisfactory as costly, in their construction and working. The frequent occurrence of disastrous floods in London south of the Thames since their completion, and the fouling of that noble river for miles below London, in compensation, I suppose, for some purification effected above by these colossal works, would alone be conclusive as to the erroneous principle on which they were planned. My late gifted friend, distinguished both in literature and science, Mr. F. O. Ward, an active but too little heeded member of the last Commission of Sewers, when protesting against the idea of intercepting, along with the sewage proper, all the rainfall descending on the surface of the metropolis, and at great cost pumping much of it into the Thames below London, tersely set forth the right principle in words which deserve to become proverbial: 'The rainfall to the river, the sewage to the soil.'

The governing body at Paris has recognised this truth, and, in accordance with a most able and exhaustive report from M. Millet, their chief engineer, has been for some little time acting on it in the plains of Genevilliers; so as not only, as I have seen on the spot, to purify the great volume of sewer water already conducted thither as the precursor of much more, but also at the same time to fertilise with it a large tract of market garden, which filters the sewer water on its way to its final discharge, clear and bright into the Seine. Though at my first visit in 1834 Paris had the roughest granite paved roadways, with hardly any separate footways in the streets, and scarcely a single sewer or house-drain, Paris will, I expect, before long be as superior to London in its subterranean as it has for some time been in its surface arrangements. The sewers and house-drains will be as much better managed there as its streets and roads in respect of smoothness, cleansing and watering have for some time been. I have been told that Berlin also, profiting, as the Board of Works has not, by the publications of the first Board of Health, will before very long surpass

London in its sanitary arrangements, in its water supply at constant pressure, in its hydrants, in its house drainage and street sewerage, and in the profitable use, instead of the noxious deposit, of the sewage.

The undiminished—indeed, for more than a decade, the slightly increased—mortality of the metropolis, after the great sums expended in it upon house-drains and sewers since 1854, affords melancholy proof, apart from the testimony of our noses, that many of these new house-drains and sewers have not been constructed upon the self-cleansing principle successfully adopted years ago, at very moderate cost, in many provincial towns, with large reductions, when their water supply was good also, in their previous mortality and sickness. The mortality in Dover, for instance, was brought down to 14 per 1,000, more than a third below that of London; in Croydon, Salisbury, and Bedford it has been brought down to two-thirds of their previous rate; in all much below London, and in all with corresponding reduction in the amount of sickness.

But what was to be expected from a Board elected by such bodies as too many of the metropolitan vestries? I have some recollection still of the curious administrative acts of the vestries of Marylebone and St. Pancras, of which I became cognisant as secretary to the Metropolitan Board and chairman of the Metropolitan Commission of Sewers before representing that borough. I well remember the interest at that time taken by them in Imperial politics, and their constant discussions upon the foreign and domestic policy of the Ministry; and also their contemporaneous—I suppose I must not say consequent—costly mismanagement of their parochial workhouses, burying-grounds, and schools. Some of these facts may probably have been in Mr. Charles Dickens's mind when he so happily described the Metropolitan Local Management Act as 'an Act for the more complete vestralisation of the Metropolis.'

I have mentioned the costly mismanagement of the sewers of the Metropolitan Board of Works under that Act. But all experience has confirmed the truth of the principle laid down as long ago as 1842 by Mr. Chadwick, that the best-planned sewers and house-drains of the most approved form and best materials, without an adequate and constant supply of water, would become in dry weather merely elongated retorts for the generation and diffusion of noxious gases; that on the other hand, a large water supply without good drains and sewers would render the site of most towns unwholesomely damp, and of some quite marshy; that in the case of the poorer dwellings, intermittent water supply, from however pure a source, means contaminated supply, owing to its stagnation in foul cisterns and decaying waterbutts, rendering it hopelessly unpalatable to drink; that therefore both good sewers and good water supply are alike requisite; that each is indispensable to the other's satisfactory action; and that no town could be considered in a proper sanitary state while either was grossly defective. This point I must presently recur to. I will now shortly review the general course of sanitary legislation and administration in the last quarter of a century, and describe the statutory powers and departmental arrangements under which the Government prepared to act.

After the supersession of the first Board of Health, the Board completely changed its character, which could hardly be otherwise than retrograde, when Sir B. Hall, one of the most persistent and formidable of the first Board's opponents, was placed at its head. In 1858 the Board was completely abolished, and most of what sanitary work the Government still undertook was made over to the Home Office, which had a new special Local Government Department established in it; certain duties being assigned, however, to the Privy Council, to which Mr. Simon, the medical officer of the last Board of Health, was transferred when it expired.

A variety of Acts, more or less comprehensive, dealing with sanitary matters, were passed at intervals, unconnected, and with provisions sometimes almost, if not quite, conflicting here and there, never having had their mutual relation carefully considered. These Acts left action under them a matter of extreme difficulty and complication; as I know from having with varied success sometimes tried, and much oftener wished, to act under them. For the execution of sanitary works, however pressingly needed, was hampered with many legal difficulties, and involved often considerable risk to the authorities who undertook the responsibility of ordering them. I remember on one occasion being, with the Vice-Chairman of my Board of Guardians, surcharged, I believe rightfully, by the auditor 200*l.*, the cost of some undeniably urgent works, which we got executed in a village when cholera had actually broken out in a not very distant market town in our Union. Most complicated points of various kinds arose out of this case, and it was a long while before the surcharge was finally remitted by the Board above, and the question decided whether the parish or union should pay the money instead of us. The paralysing influence of such a surcharge upon all sanitary efforts, wherever it became known, may easily be imagined.

In 1869 the Royal Sanitary Commission of inquiry was appointed; and, after taking much evidence, made most valuable reports, upon the practical recommendations in which, and especially upon the most important of them, subsequent sanitary legislation was mainly, though unfortunately not quite without exception, based: that recommendation being, that there should be one Local Authority for all public health purposes in every place, so that no local area should be without such a one, or have more than one.

'In 1871 the Local Government Board,' as it stated in its eighth Annual Report (1878, cxxviii.), 'was established, and the powers and duties of the Poor Law Board under the Poor Law Acts, of the Secretary of State under the Registration Acts, the various Sanitary Acts, and the Local Taxation Return Act, and of the Privy Council under the Prevention of Diseases and the Vaccination Acts, were transferred to the new Board thus created, while in the following years the powers and duties of the Board of Trade under the Alkali Acts and the Metropolis Water Acts, and of the Secretary of State under the Highways and Turnpikes Acts, were in like manner transferred to the Department.

'In 1872 the whole country was, by an Act passed at the instance of the then President of the Board, divided into urban and rural Sanitary Districts, and each district was placed under the jurisdiction of one Sanitary Authority and one only, and provision made for the establishment of a Port Sanitary Authority for every port in England and Wales.

'In 1875 a measure prepared by us was passed for consolidating the whole of the sanitary laws into a single Statute, thus reducing into a methodical and complete whole provisions which hitherto had been scattered over no less than twenty-two separate Acts of Parliament.

'In 1877 we issued complete sets of model by-laws, relating to almost all the various matters which local authorities are empowered to regulate by by-laws under the provisions of the sanitary law.

'Thus it will be seen that during the last seven years a single central authority has been established and organised for superintending the administration of the laws relating to the public health, poor relief, local government, and local taxation.

'Secondly, that the entire country has been divided into Sanitary Districts, and a local authority for sanitary purposes established for every district, so that no area is now without such an authority, or has more than one.

'Thirdly, that the sanitary law has been amended and reduced into methodical form for the guidance of the several Sanitary Authorities referred to; and

'Fourthly, that they have been supplied with a code of subsidiary regulations, which, when adopted, will enable them to give full effect to the more general provisions of the law.'

The value of the service thus rendered to sanitary reform by the consolidation of statutes and unification of authority can only be adequately appreciated by those who, like myself, had been for years practically engaged in trying to promote and enforce it in a district under some of the twenty-two sanitary statutes above mentioned, mostly passed in the previous quarter of a century, with some of their clauses left still valid, some half, some wholly, repealed or superseded. Still to this valuable consolidation and unification there have been, even quite recently, several unfortunate and decidedly retrograde exceptions, which would be unaccountable, but for the tendency in every Government department always eagerly to grasp at fresh powers and reluctantly to relinquish any once possessed. Thus we find that while according to obvious analogy, and in conformity with the recommendations of the Royal Sanitary Commission, all the control of dairies ought to have been vested in the Local Government Board, by the Contagious Diseases (Animals) Act of 1878 it was given to the Privy Council. As I most earnestly pressed the necessity of such a measure upon the Government on behalf of the Central Chamber of Agriculture of which I was chairman, and on behalf of almost every provincial chamber besides, it was not for me to place additional difficulties in the way of a measure in conformity with the sound principles of political economy and of physiological science, by objecting to the authority proposed by Government, however ill selected, when the Bill was vehemently opposed on the calumnious plea of its being protectionist legislation. As I said at the time, having been a consistent free trader from my youth, all we wanted for the British farmer was protection from foreign contagion, not foreign competition, which the free admission of dead meat already secured for the consumer. As stated above, the assignment of any jurisdiction over dairies to the Privy Council is contrary to sound principle. And for this the late Government was responsible. But under the present Government we find that by the Merchant Seamen's Act just passed, the by-laws for lodging-houses for sailors are to be approved by the Board of Trade, while the regulation of all other lodging-houses, whether in ports or inland towns, comes, like other sanitary matters, under the Local Government Board. So much for retrograde sanitary legislation up to the present day.

I now come to retrograde administration, of which signal instances are afforded by both the late and present Governments in their treatment of the water supply of the metropolis.

As the recently established Local Government Board had stated in their eighth report already mentioned, they had a sanitary division in that department with sanitary duties and officers—medical, engineering, and others—transferred to it from other Government departments. This sanitary staff was costly indeed in salaries, but cheap in proportion to the high qualifications of its members for dealing with all kinds of sanitary questions. It comprised a chief engineer, Mr. R. Rawlinson, C.B., who is a member of the Council of the Institute of Civil Engineers, and had distinguished himself as a specialist in dealing with water supplies. He had in 1847 proposed to take the water from Bala Lake to Liverpool, and had afterwards been a member of a Commission of Enquiry into the London Water Companies. He had, moreover, taken a leading part in advising the authorities of several towns about the purchase of works from trading companies so as to make them public instead of private concerns, which had been accomplished to the general satisfaction of the inhabitants. The Department had further the advantage of comprising an able water examiner, and also an auditor of the Water Companies' expenditure, both specially for the metropolis. At the head of the Local Government Board there was a gentleman not originally known for any special sanitary work, but who had while there so much of it passing under his general superintendence, that with his businesslike qualities he could not have helped becoming tolerably conversant with sanitary questions.

Moreover, the question of protection from fire in London, necessarily involving that of the water supply, had been recently carefully examined and considered by a Committee of the Society of Arts, to which several of the officers of his department had, with leave from the President, given valuable information. On the report of that Committee a Bill had been drawn and proposed by some private members, which had been seen and in its main principles approved by him. He and his Department were, therefore, to a certain degree prepared to deal with the question. It was not, however, to the Local Government Board and Mr. Sclater-Booth, but to the Home Office and Sir Richard Cross, that the question was to be confided—a minister, indeed, of remarkable industry and unquestionable ability, of which he had recently given signal proof in his measure satisfactorily adjusting the legal relations between employers and servants. But he had neither the special knowledge himself requisite for dealing with the very special question which he unfortunately undertook, nor could he any longer find, in the Home Office, officials practically conversant with such matters to help him. But before describing or discussing his (as it proved) very unsuccessful course of proceeding, I must be allowed to give a further illustration, without at all disparaging the high qualities of our statesmen, of the way in which the public service often suffers, both from departments being assigned to the wrong men and from business being allotted to the wrong departments. There was a right honourable gentleman in Mr. Gladstone's last Government, a man of science, and indeed a specialist in sanitary knowledge. For as a member of the Commission for Enquiry into the Health of Towns, he had written a most able report on the Sanitary Condition of Lancashire; and on account of his special knowledge he had been placed in the chair of the Select Committee on the great scheme for supplying Manchester with water from Thirlmere. The Local Government Board required an able man conversant with sanitary matters, as several sanitary questions were urgently demanding solution. The Foreign Secretary had while in opposition called the attention of the House of Lords to the state of the water supply of the metropolis, and the late Prime Minister had a few years before eloquently and justly dwelt on the great national importance of sanitary reform; indeed, its powerful influence, direct and indirect, on the pauperism alone of the country, not to mention anything else, is undeniable. Here, one should have thought, was obviously the right man for the place. But no, Professor Playfair, who had had no special training for the Chairmanship of Committees, was put there; and Mr. Dodson, conversant with its duties, having held the post before, but whose name is, I believe, unknown in connection with sanitary work, was placed in the department where, with very slight exceptions, all the Central Government's sanitary work has recently been concentrated. Still, being so able a man as to be put into the Cabinet, with the aid of a permanent staff under him so thoroughly conversant with the water question, he would probably have dealt satisfactorily with it. But no, the new Home Secretary, an undeniably very powerful speaker, though destitute I believe of any special sanitary knowledge, and certainly of any previously administrative experience, for he was only a law officer of the Crown under Mr. Gladstone's last Government, followed his predecessor's example, and took the question into his own hands.

As great general principles are involved in the case of the Metropolitan Water Supply, which are also involved on a less extensive scale in the cases of many much smaller towns in connexion with public services of that or analogous kinds—those, that is, where the particular service or supply rendered has only a local as distinguished from a general value—I may, perhaps, be allowed to state the views which I have long entertained upon them.

I said, in my lecture at Plymouth in 1845, 'In cases where, for the supply of a limited because merely local demand, the fixed capital invested bears a very large proportion to what is called reproductive or circulating capital, no effectual competition can take place. Unless the exorbitant charges provoke, or the exorbitant profits tempt, some other party to contend with the original one for the occupation of the whole or a part of a field not large enough for two, the monopoly is complete, limited only by the willingness of the public to consume at the rate charged, and by the dread of the establishment of a rival party. As the probability of this latter occurrence varies, so will the prices; they will fall when the danger is imminent, and be slowly raised as it subsides. If another capital is invested, for a time competition is sharp; but before long the two parties find it their interest to coalesce, and to charge the public for a supply produced by the application of two fixed capitals, where one would have sufficed for the work, as high a price, on the same principle and subject to the same limitations only, as those which affected the returns upon the original capital.'

Therefore, as I said in my address to the Statistical Section of the British Association in 1877, 'The gas and water works of the smallest town or village, with a plant of less than 1,000*l*., would have, and ought to be treated as having, a monopoly; because the whole value of the water and the greater part of that of the gas supplied depends upon its position, and the greater part of the cost of supplying it consists in the interest on the capital invested in the fixed and permanent works. The water, which is to be had for nothing but the trouble of dipping for it in the brook below, derives its whole value from the convenience of its position in the waterpipe, which brings it into the house from the reservoir or forcing-pump. The value of the service of a coach or omnibus depends equally on its localisation; it, like a railway, takes people who want to go from some particular place to some other. But then the cost of its service consists chiefly in circulating or easily transferable capital in the shape of the vehicle, horses, and harness, equally available at a slight expense to render similar service elsewhere; whereas the materials of the reservoirs and the pumping engines and pipes in the case of waterworks would only, if transferable elsewhere at all, be so at an expense very heavy in proportion to the concern.'

I further said, in my lecture in 1845, speaking of the abstract principles on which, in cases where the field was quite open and the gas or water company had under legal sanction occupied the ground, 'On the whole, it seems to me that the necessary works for similar purposes are best constructed by individuals or companies—for the action of self-interest will induce them to do it better and more watchfully—with a monopoly granted to them for a certain time on certain terms; after which the works themselves should revert to the town, or become purchasable by the town for a certain amount: that afterwards they should either be managed by the corporation, or, better still, be let by public auction by the corporation to parties, either with certain fixed conditions attached to them at an annual rent to be decided by competition, or else be let at a fixed rent to whatever party will undertake to guarantee the cheapest and best supply to the town. These systems seem to me to combine, to the greatest degree practicable, the energy and economy observable in undertakings carried on by interested parties as compared with public bodies, with due security from the unreasonable charges or ruinous and wasteful competition of companies or individuals undertaking for profit works which are too important to the public, and at the same time too much monopolies in their nature to be advantageously entrusted unreservedly and for ever to interested parties.'

Such were and are my abstract opinions upon the question. I said at Plymouth, three years ago, that practically 'The sound view with regard to these questions of local public service and supply would seem to be that long ago indicated by Mr. Chadwick—namely, that they should be recognised as, in their nature, monopolies, but, as such, considered to be the property of the public, to be alienated in part for a time, or retained in their own hands by the State or local authorities, as may seem most for the public advantage. That this view is gaining more and more acceptance is evident from the number of municipalities which have already either set up for themselves, or have bought from their original proprietors, the waterworks and the gasworks of their towns, and are working them for the benefit of the inhabitants. Some have already done this with one or both for many years; many more are taking steps to do so; and the Metropolitan Board of Works have now for some time been wisely contemplating buying up both the water and gas works of the metropolis, and consolidating under one management what now occupies the staffs of a number of companies. The very able report presented to the House of Commons by the Committee under the efficient chairmanship of Sir H. Selwin-Ibbetson, after taking evidence for two sessions on the subject of the fire brigade of the metropolis, gives, in my opinion, conclusive reasons in favour of its various recommendations —the most material of them being that the Metropolitan Board of Works should purchase all the waterworks within its district, establish a constant supply at high pressure, and place hydrants all over London, putting the duty of extinguishing fires in the hands of the police, with a special superintendent and a special staff to attend particularly to this new branch of police work.'

This general view the late Government seems to have adopted, and the present one also, to a certain extent, judging by the report carried by the Home Secretary in the Select Committee the other day: though the two Governments seem to have differed considerably as to the principles on which the compensation (if any) to the companies should be based, and as to the composition of the body or trust to whom the making of the arrangement should be confided.

The former Home Secretary had intimated that a great amount of capital would have to be raised for the purchase, from which it was naturally inferred that there would be an augmentation of charges on the ratepayers. But the evidence of poor Mr. Edmund Smith, his own valuer, a man of remarkable integrity and ability, much esteemed and much regretted by the department which he had served, showed that this view was quite wrong, and that the view stated by the Committee of the Society of Arts was quite right; that not one shilling of capital would be required for the purpose; but that, on the contrary, the ratepayers would secure from the unification of administration, and from discontinuing the use of the less advantageously circumstanced of the existing companies' works, an annual gain of at least 170,000*l.*, or far more according to the Committee of the Society of Arts. I may add that much of this, after paying the companies compensation for their prospective advantages, would be applicable at once to hydranting the streets and other much needed improvements. The other great error, equally maintained by the present Home Secretary, was that the sale price of the companies' shares on the Stock Exchange should be a basis of the purchase, which spread abroad the idea that as they went up in the market the increased price would somehow or other come out of the ratepayers' pockets. But in the purchases which had given satisfaction to the provincial authorities no such basis was adopted; and for the reason that the sale price in the market is that which the few who are obliged to sell must take, not the price which the great majority, who were permanent investors, would accept—as Sir E. Beckett, in his most able speech, conclusively showed. Besides, the sale price on the Stock Exchange may be dexterously rigged, as it is called, for a purpose. The sale price of an undertaking, such as that of the water companies, is determined in practice, after adding the compensation for prospective advantages, forced sale, &c., by their average net income or dividend, which, in this case could not be falsified, being subjected to the strictest scrutiny by a Government auditor. No doubt the shares rose at the probable prospect of obtaining a public security. But this did not come out of the ratepayers pockets. If, instead of the two Home Secretaries, quite unaccustomed to such transactions, the question had been put into the hands of the late or the present head of the Local Government Board, he would of course have consulted the chief officers of his department as to the usual practice, and the matter would have been probably settled before now, and an increased chargeability, which Mr. Smith showed was accruing at the rate of full a million a year, or near 3,000*l.* a day, would have been arrested. I am not defending the exact arrangement proposed by Sir R. Cross and Mr. E. J. Smith. I do not know enough of the details to give any positive opinion upon the subject. I am only contending that though, as I think I have shown, it was undertaken by the wrong minister at the head of the wrong department, it did not deserve the outcry raised against it. And I contend, further, that it is most desirable for some reasonable arrangement to be speedily come to, far more in the interest of the inhabitants of London than of the companies, whose gains will increase largely with delay; unless, indeed, a new principle of dealing with property generally is adopted by the Legislature. The language of the report carried by the present Home Secretary in the Select Committee of the House of Commons, has already inspired some holders of shares in undertakings embarked in on the faith of Parliament with much of the distrust, with which more than one measure proposed by the Government during last session has notoriously inspired many landowners in Great Britain as well as Ireland; discouraging the further investment of capital either in the improvement or in the purchase of land. Capital, it has been well observed, is one of the shyest and most timid of creatures, and at the same time so subtle that there is no restraining its flight when once alarmed.

On the principles laid down by the first Board of Health, various water and gas works have been purchased by the local authorities of various towns, and usually to the general satisfaction of the inhabitant; the better security thus permanently obtained by the companies for their income helping to render them willing to accept reasonable terms.

The Home Secretary opposed a resolution for any declaration of terms of purchase, and declines altogether, on the part of the Government, to undertake the task of settling the question. And to whom does he propose to entrust it? To a trust composed of representatives (1) of the Metropolitan Board of Works, (2) of the Corporation of the City of London, and (3) of other local representatives of the metropolitan area. Let us take them seriatim: (1) the Metropolitan Board of Works, of whose 'costly mismanagement' I spoke at Plymouth three years ago, and have given some instances to-day; whose proposals with regard to water supply had been rejected by the Select Committee on the Fire Brigade as wasteful and ineffective; whose finance, as displayed before this very Water Committee, had been proved to be unsound, and their leading witness absurd; (2) the City Corporation, whose views also were shown by Sir E. Beckett to be unsound; and (3) lastly the metropolitan parish vestries, of whose incapacity for such a task I have already spoken.

The body proposed is unfit itself to make the bargain, in the first instance, and to complete the arrangements for the constant supply and hydranting, from its confessed want of the very special knowledge required in this difficult and important task; and such a body would be very unlikely, judging from experience in analogous cases, to be influenced in the choice of its professional guides in the matter by sound judgment and public spirit alone. These are obvious reasons for the devolution of this merely temporary duty to some one, two, or three persons appointed by the Crown, and selected *ad hoc* on the responsibility of the Government. The appointment of a practical dictator for a short time to act in a particular crisis has not been unknown under republican governments, ancient and modern. Of course it is very easy and popular to profess implicit reliance on local self-government, the principles of which I have of late years constantly found myself pleading in vain against the centralising action of successive bureaucratic ministries. It is easy and popular to devolve upon the particular representatives who happen to be chosen in a particular year by different representative bodies, themselves elected by the ratepayers of the metropolis, the responsibility of making arrangements deeply affecting for better or for worse the permanent interests of the inhabitants; of concluding a bargain permanently pledging rates amounting to hundreds of thousands of pounds a year, and consequently equivalent to many millions of capital. But this seems to me to be only shabbily shirking a difficult and ungrateful task to the probable detriment of the metropolis for many generations to come. I have always contended, along with those who have given most attention to such administrative and economical questions, that some control on the part of a central authority over the acts of the elected authority for the time being in any locality (a control generally undesirable, when only the expenditure of the year's income is concerned), becomes not merely justifiable but desirable when the liabilities contracted are to burden the ratepayers of the future. Waste of the year's rates brings its punishment on those who have incurred it. Permanent obligations improvidently contracted punish unborn generations for the mistakes made in the choice of representatives in a single unlucky year. This is unavoidable in the case of Parliamentary elections. But there seems no adequate reason for extending the risk unchecked further than can be helped, especially in a case like the present, when it is neither called for nor expected by the inhabitants of London generally.

The other question is whether it can be right in principle, or probably successful in operation, that such a body as has been proposed should be charged with the permanent management of the water supply of London; or that this duty should be kept quite separate from the management either of the sewers and gas-pipes underground, or of the roadways and pavements on the surface?

The fact is sanitary science may be said to have done its work, and the reward of conformity to its dictates has been reaped wherever they have been faithfully followed. It is legislation, or rather the administration of bodies acting under legislative authority, that is really in default.

To begin with the management of the metropolis. Notwithstanding the considerable amendments some of us got made in the Metropolitan Local Management Bill, I said on the third reading that I had no hope of its affording a wise, efficient, and economical system of local administration. In saying this I had particular regard to its reversal of Lord Carlisle's enlightened policy of consolidation by the establishment of thirty-six new district authorities —all placed under the new Metropolitan Board indeed, which was charged with the main drainage of the metropolis, but each having the separate control of the street and house drains in its own district. I had previously urged that this great multiplication of separate engineering staffs was a most retrograde step, and would at once add largely to aggregate cost while diminishing efficiency; that the officers under these numerous authorities would probably be overpaid for the work they did, underpaid for the work they had to do—work requiring a skill and high character in those charged with its superintendence, to secure which, in its chief officers, adequate salaries could scarcely be afforded by each of the thirty-six separate authorities. I had urged that, salaries apart, the inconvenience of more than ever subdividing the area of administration, and placing each subdivision under separate authority, would be much aggravated by their boundaries following the ancient parochial lines drawn without reference to the lay of the ground; much difficulty and delay in the co-operation desirable within the same natural drainage area being unavoidable, even when mutual jealousy accorded any at all. Instances were known in the case of the seven old Commissions, where large sewers belonging to one Commission above were made to discharge into small ones belonging to another below, and even where the sewage was invited (it could not be persuaded) to flow up hill.

I earnestly pressed, therefore, that if the work, which the late Crown-appointed Commissioners had not at all despaired of carrying on successfully with the aid of a competent staff, was thought too much for the new Representative Board to undertake, the right course was to divide London into two independent divisions, north and south of the Thames, each complete in itself with its unity of action unimpaired. But no heed was given to my representations in Parliament or to those of the sanitary reformers outside, though founded on years of practical experience: for they were unacceptable to the vestries, whose influence, joined to that of other interested parties, was then paramount. The measure was passed accordingly, unaltered in its main features, with the consequences which we have witnessed. Several greatly improved communications, indeed, and a grand work, the Thames Embankment, have been completed, at great, and I am informed undue, expense by the Metropolitan Board. But they found an ordnance map, and subterranean survey, finished with the lines of existing sewers and the levels of the streets marked upon it, and trial-works established for testing the best sizes for house-drains and sewers, the best mode of utilising sewage for agriculture, &c., so as to enable them to carry on vigorously the system inaugurated by their predecessors. Neither the Metropolitan Board nor the thirty-six vestry boards have turned what they found prepared to much account. I have already spoken of the former's enormously costly mistake of the gigantic outfall sewers and their huge pumping engines. They have further made some 150 miles of main sewers, reported to be mostly sewers of deposit, only relieved by costly flushing which a self-cleansing system would have rendered unnecessary. After nearly a quarter of a century's experience of that Board, and of the thirty-six district authorities or vestries, we do not find the mortality diminished at all as it ought to be; we do not find the streets as much sweeter as they ought to be; we do not find their surface either as smooth or as clean as it ought to be, and as it is at Paris; we do not find the house-drainage as much improved as it ought to be. Not only do we hear of many private houses of the rich and very many more of the poor, but latterly of several public offices, as being much tainted with sewer gas. Not only the long notoriously pestiferous War-office; but even the stately new offices, are in disgracefully bad sanitary condition. At the Institute of Civil Engineers the chief engineer of the Local Government Board recently stated that no new public building in Great Britain could be in worse sanitary condition than was the office of his department; that the stench in some parts of it was sometimes horrible; that according to a report in his possession the sewers of Whitehall, Downing Street, Great George Street, and Victoria Street were flat-bottomed, never flushed, had a deposit of more than fifteen inches in them, and yet were unventilated. An excess of some seventeen thousand preventable deaths annually, about a hundred fires allowed to become serious and some twenty persons burnt alive for want of a system of hydrants under constant-pressure, are the penalties of this mismanagement. And yet, as we householders know too well, the rates have much increased and keep increasing, being swelled by the interest yearly payable upon the large debt of the Metropolitan Board, which, already, before last year, exceeded ten millions. I do not say that they have done no good with all this money: but I affirm none nearly commensurate with the cost, though the present Home Secretary, with his usual self-confidence, recently pronounced the works of the Metropolitan Board to be "dirt cheap."

In 1854, little more than half a year before my triumphant return for Marylebone, beating another Liberal who had the enthusiastic support of the vestries, I published a pamphlet on 'Representative Local Self-government for the Metropolis,' which was freely quoted against me during the contest. I believe, however, it gained me more votes than it lost me. As subsequent experience and reflection have only confirmed me in the main views therein set forth, I think it not irrelevant to repeat them here, feeling satisfied that the bad sanitary example set by London is a serious impediment to the advance of sound sanitary principles and practice, not only in this country, but throughout the civilised world; and further, that London will not be much sanitarily improved until it has a better form of government.

I wrote in 1854, 'My present business is not with temporary palliatives, but with the redress of permanent grievances; for which, in other capitals, redress may be obtained by means of duly empowered local authorities; but which, in London, even when of the most trifling natures' (witness the Cab Act), 'can only be dealt with at the cost of legislative and administrative time and thought required for the interests of an empire upon which the sun never sets. No wonder that the inhabitants of the metropolis are dissatisfied with its present state and management.

'Hence the various schemes propounded for the purpose, of which the most prominent are—

'*a.* The creation of a vast Metropolitan Corporation, a seat in which, it is said, would be an honour not less worthy the ambition of our greatest merchant now-a-days than was a seat in the Corporation of the City in the days when all London was comprised within its walls.

'*b.* The erection of the several Metropolitan Boroughs into so many corporate towns, each with its own separate government, as if they were divided from each other by miles of intervening country, instead of by mere street-crossings.

'It seems to me that, as permanent systems, these are open to unanswerable objections.

'The two first would be representative, and so far *primâ facie* would have the advantage of giving the inhabitants a government of their own choosing. But the first would establish at the very seat of the Imperial Government a representative assembly deliberating on the affairs of two millions and a half of inhabitants, all living within ten miles of the sovereign's palace and of the Houses of Parliament.

How far would it be safe to create a corporation representing a constituency like that of the Marylebone Vestry, only ten times as large, and administering an income, as I have shown, of some million and a half sterling per annum? How far would it be safe to establish an elective chief magistrate, governing a population about equal to that of the kingdom of Denmark, but concentrated on some 120 square miles, instead of being spread over upwards of 16,000?' Both the income and population have largely increased since. 'Let the experience of foreign capitals be some warning upon this point.' The success of the mob when they destroyed the railings of Hyde Park has since proved that we need not look abroad for warnings.

'The second proposal, that of dividing London into several separate towns, each with its separate corporation, certainly looks plausible enough. Some idea of its operation, however, if applied to the present parochial or parliamentary divisions, may be obtained by looking at the management of the sewerage of London, when under seven separate commissions.' Having already described this, I need not repeat it.

'What I have exemplified by the instance of the sewers, holds equally good of all structural arrangements. I need not point out how large a proportion of metropolitan expenditure will relate to structural arrangements of various kinds, the improvement of thoroughfares, &c.; while the results of the separate action of the City police force tend to show that the evil of divided management is not confined to structural arrangements alone.'

'I think we may therefore conclude that the second plan would work neither conveniently nor economically, while it would be open, though in a lesser degree of course, to the objection of exposing the Government and the Legislature to the action of formidably powerful corporate bodies concentrated round their head-quarters.'

'The question, therefore, still remains to be solved, what kind of representative Government ought to be given to the inhabitants of London for the management of their local affairs?'

I then, after going at some length into the whole subject, summarized my conclusions as follows:—

1. That imperial interests render it undesirable for any one body to be invested with full municipal powers over the whole metropolis.

2. That unity of municipal government being thus repudiated, the

division ought, for the sake of vigour and unity of action, to be one of functions and powers, rather than of areas of jurisdiction; in other words, that the different independent governing bodies should resemble different committees of one municipality for the whole metropolis, rather than be separate corporations, each with full municipal powers over sections of the metropolis.

3. That, in the case of London, the two classes into which, as distinguished from other business not requiring unity of administration, municipal business naturally divides itself are, (1) the Regulation of WORKS, as of buildings, drainage, the supply of water and gas, paving, the maintenance and improvement of thoroughfares, bridges, &c.; and (2) the Government of PERSONS, including the administration of civil and criminal justice, the pursuit and punishment of criminals, the management of prisons, the direction of the police force, and the maintenance of order and decorum.

4. That these different sets of functions should be performed by three separate administrative bodies, each of such bodies comprising, in the first place, a certain proportion of popular representatives, frequently elected; and, in the second place, a certain proportion also of more permanent and independent elements.

5. That these bodies should be differently constituted from each other, with (1) different representative members, elected by differently qualified constituencies from different areas of representation; and with (2) different permanent members, differently chosen, and from different classes.

6. That, in the body having control over Works, the popular constituencies returning the first class of members should be divided according to the natural lay of the site of the metropolis, and should consist of the ratepayers; that the constituency returning the second class of members should be the ground landlords and long leaseholders; and that, in consideration of the small proportion of the administrative business to be transacted by the Board not immediately involving expenditure and taxation, the second class of members should be much less numerous than the first.

7. That the proportion of voters to the inhabitants ought, in the case of the body charged with the government of Persons, to be much larger; but that the proportion borne by the members returned by this constituency to the whole Board should be much smaller than in

the last instance; the proportion of business involving expenditure and taxation being in this case much less, the proportion of purely administrative and judicial business much greater: and that, for the same reason, the more permanent element, forming a majority of the Board, ought to be directly or indirectly appointed by the State.

8. That it would be easy, and probably expedient also, under the actual circumstances of the metropolis, not to place the management of the Police force and the administration of the criminal and civil justice under the proposed Board, but to leave them, as now, under the control of the Imperial Government. That, notwithstanding the reserve of these large functions, quite enough of business for the employment of the Board would remain in the regulation of prisons, lodging-houses, public conveyances, the house-to-house visitation of the poor, and the financial business connected with the government of persons: but that in this case a larger proportion of the representative element should be introduced into the Board, in consideration of this change in its duties.

And now, having, I fear, exhausted your patience and spent nearly all my time on London, I have not much left for speaking about sanitary matters in provincial towns and country parishes. With regard to the towns, I must repeat that all the best results have been obtained only where the works both of sewerage and of water supply were complete, and this is far from being general. We find Manchester, for instance, with its admirable system of water supply on a public footing, has a high mortality, because, I am told, its house supply is extensively deficient, and that it is in great measure a city of 'middens' and cesspits. The tub, happily abolished there as a receptacle for clean water, yet as a receptacle for stagnant filth frequently, but not frequently enough carted away, takes the place far too often, both unwholesomely and expensively, of the self-cleansing house-drain through which the sewage begins to flow off as soon as it enters.

In 1875 I moved for a Return of the sums spent on drainage and water supply in certain towns in Lancashire, and of the deaths from all causes, and specially from zymotic diseases, in the same years, and also of the duration of life of different classes in them, and in the county of Rutland. I will read them shortly to you, with regard to Manchester only.

In the ten years from 1864–1873:

	On drainage and sewerage	On water supply
Manchester spent . . .	105,789*l.*	863,544*l.*
Rutland county spent . .	1,864*l.*	certainly nothing

But the return in Rutland is incomplete as to drainage, though the amount is stated to be very small.

And there died:

		Manchester		Rutland
From all causes . . .		82,424		20,329
Of zymotic diseases	(more than $\frac{1}{18}$th)	4,406	(less than $\frac{1}{30}$th)	675

The average ages at death in the thirteen years from 1861–1873:

	Manchester	Rutland
Of the gentry and professional persons and their families	44·6	48·1
Of tradesmen, &c., and their families .	28·9	44·4
Of labourers, mechanics, and servants, and their families	24·4	36·0

I selected Rutland for comparison, knowing nothing about it except that it was an agricultural county so small that the information would, I thought, be easily obtainable.

To take another town. Those who know Birmingham and its fine site, declare that there can be no other reason why, instead of 24 in 1,000 according to the last returns, its deaths should not be 16 in 1,000, or even as low as they were several years at Dover, 14 in 1,000, except the inhabitants' ignorance of the duties of self-government: no reason why they should have an excess of 2,600 deaths above a healthy standard, except their neglect to profit by the sanitary lesson afforded, according to the statement of the Medical Officer of Health, by two institutions close to Birmingham. One of these is for destitute children, where the death-rate was only 3 per 1,000; less than a quarter, probably, of that to be found among the ill-cared-for population of that city, for whom the application of the same principles with the same results would save 1,600 children a year. The other excellent example is the prison, where the officer in charge stated that the death-rate among those who came in without already developed disease was not more than 2 in 1,000. A similar rate in that unfortunate city would imply the saving of more than 2,000 deaths annually. The wage-class there have had much said to them by their leaders about the privilege of the franchise for themselves and others, a privilege justly dear to the citizens of a free country. But I cannot help thinking that it would be better for them to seek not less eagerly the privilege of living to their natural term of life, with a corresponding extension of the duration of their working ability. The highest eloquence of one of their two right honourable members, and the best administrative skill of the other, might be profitably directed among other objects to such an application of sanitary principles as would bring the condition of their independent constituents' children up to the level of that of pauper children in a well-regulated institution, and afford their honest constituents of the wage-class the same prospect of health and life as thieves have in a well-managed prison, or vagrants in a beggars' lodging-house under Lord Shaftesbury's Act.

Reminding you that the mortality of children under five affords the best and most delicate test of the healthiness of a place, I must give you a few figures about the three towns of which I have been speaking—London, Manchester, and Birmingham.

	London	Manchester	Birmingham
Estimated population in the middle of the year 1877 . . .	3,533,484	359,213	377,436
Deaths at all ages:			
Mortality per 1,000 living .	21·9	27·4	24·2
Number registered . . .	77,449	9,810	9,104
Number if mortality had not exceeded 17 in 1,000 living .	60,069	6,107	6,416
Number above the healthy standard of 17 *in* 1,000 *living* .	**17,380**	**3,703**	**2,688**
Deaths of children under five years of age:			
Deaths registered:			
Number	31,891	4,025	4,461
Proportion per 1,000 living .	69·7	83·1	84·1
Proportion to 100 deaths at all ages	41	41	49
Number if general mortality were 17 in 1,000 living, and the proportion to total deaths were 25 per cent. . .	15,017	1,527	1,604
Excess of deaths registered over number in preceding line .	**16,972**	**2,498**	**2,857**

We have had eloquent declamation enough about the horrors of war. Still, along with the terrible amount of suffering and crime incident to it, no one can deny that war also calls forth in the nobler natures engaged in it some of the finest qualities of man—patriotism, courage, endurance, self-denial, self-sacrifice—not to speak of the lofty Christian heroism of men like Havelock. If peace has its victories no less than war, peace has its victims far more numerous than war. For instance, the needless waste of life in the United Kingdom during the Crimean War, was many times greater than the loss of life in that war—a waste accompanied by the long train of physical, intellectual, moral, and spiritual evils involved in general degradation. All experience shows that, as a rule, dirt, disease, and vice are concurrent; that, with rare exceptions, families cannot lodge like pigs and live like Christians.

With regard to fresh legislation, the first Consolidated Sanitary Act of 1875 seems to embody most, though not quite all, that is wanted. The principle of distributing the cost of works, and especially of the smaller kind, over a series of years by the Improvement Rate, first sanctioned in the Metropolitan Sewers Act of 1848, has been far too little encouraged or adopted. It may seem rather complicated at first, but we found by the aid of tables it was easily worked, and it practically averted, to a great extent, difficult and intricate questions of ownership as regarded chargeability for such works, since the occupiers were generally satisfied that they received benefits from them well worth the extra rate to be paid for them. The principle, also, of engaging an officer's whole time for the public service, and employing it in any public duties not practically incompatible, seems worthy of much more extensive adoption; not only because of the great saving in trouble and correspondence, to which it conduces when co-operation between different authorities of any kind is required, but also because it removes the temptations to sacrifice public duty when it conflicts with private interest, which must sometimes arise in the case of a public officer having also private practice. Unfortunately the boundaries of the unions which must, now that the parish has been almost wholly superseded in that respect, be regarded as the unit of local administration in England, are in so many cases incongruous with those of the county as to present great, though I hope not insurmountable, difficulties in the way of what I have long wished for—the establish ment of representative county boards as general intermediate authorities between the union and Downing Street. Administration is now much more in default than legislation. As the Sanitary Commissioners say in their Report:—

'The system of self-government, of which the English nation is so justly proud, can hardly be applied with success to any subject, unless the governing bodies comprise a fair proportion of enlightened and well-informed minds; and if this be true as a general proposition, it is especially true in regard to matters affecting public health.

'In the next place, many sanitary questions of vital importance are from their very nature incapable of being completely provided for by any amount of legal enactment, however minute and explicit. So large a discretion must of necessity be left to local authorities as to details, that in practice much will always depend on the energy and wisdom of those who compose such authorities. Moreover there are limits to the power of any central authority to remedy the evils produced by local inefficiency. It may control, stimulate, and in some cases supplement the efforts of local bodies, but it cannot be a substitute for them.'

This has been practically recognised by the Legislature, and as Dr. Acland truly observes in his recent address:—

'On the education and voluntary action of the people depends now before all things their sanitary condition. They have the means of obtaining knowledge, they have the means of obtaining power. If they have the will they can obtain both. There are good books now and to spare on every branch of the question—legal, engineering, chemical, medical, &c.'

I further agree with him when he says:—

'Compulsory powers should only be exercised by the central authority in the most extreme cases, and this should be clearly understood to be the principle of action; but, as a corollary, the central authority should with the utmost freedom collect the best information, and disseminate it in the freest way. If the Treasury should not sanction the gift of Reports, every local official should receive notice of all Government Health publications, with the statement of the contents, cost, and where to obtain them, immediately on their issue. This would promote progress of education—

and would, quite certainly, be done, and is the least that would be done, *mutatis mutandis*, by any large private company dealing with the subject. It is being done to some extent by the model bye-laws recently issued, but should be done much more extensively.'

This constant diffusion of sound principles and of practical information by the wide distribution of these official Reports, as well as by their general circulars and separate letters to the unions, was largely practised by the early Poor Law Commissioners. But I found, when I became secretary to the Poor Law Board, that very little more than the mere necessary formal sanctions and orders had been for some time issued from the office. The same remark applies to the change of policy in sanitary matters on this point ever since the suppression of the first General Board of Health.

When the Treasury were stopping the former wide circulation of Reports, &c., on the plea of expense, I hardly ever recollect any member of any Government throwing any impediment in the way of the granting and printing of masses of useless papers moved for in either House, however useless he knew printing them to be. The mere adoption of the system of printing large numbers long adopted by the Statistical Society, of omitting the hundreds or thousands in all cases of tables of figures where minute accuracy is not required (and to how vast a proportion of them does this not apply?), would have saved over and over again the cost of continuing freely to diffuse information tending the weal and wealth, because the health, of the community. It was economising the means of economy. *Magnum vectigal parsimonia.* But refusing the useful expenditure pleased many of the same class of members that refusing the useless expenditure would have offended.

Ministers may declaim grandly about sanitation, yet we have always found honours and encouragements markedly withheld from every sanitary reformer—*laudatur et alget.* The Local Government Board has for some time had the double charge of supervising the poor relief and the sanitary administration of the country. I am sure I am not at all disparaging the valuable public services rendered by my friend Sir John Lambert, when I compare his in both departments with those of my valued and honoured old friend Mr. Chadwick, who took the chief part in preparing the great Poor Law Reform Act of 1834, as well as the convincing and exhaustive Report of the Commission of Enquiry, which paved the way for it; and who, after years of able and energetic work as secretary to the Poor Law Commissioners under that Act, equally prepared the way, by his masterly Sanitary Report of 1842, for the Public Health Act of 1848, and afterwards, as member of the General Board of Health under that Act, rendered such valuable services (nowhere so little appreciated as in his own country) to the cause of sanitary reform throughout the world. Not only have foreign sovereigns recognised this on various occasions, but the illustrious Institute of France years ago paid him the rare compliment of electing him into their body. Yet, while Sir J. Lambert has deservedly been made a Knight Commander, his far greater predecessor is only a Companion, of the Bath. To take another striking example, Mr. Rawlinson, sanitary engineer to the same department, of whom I have already spoken, received the same honour as Mr. Chadwick; but it was for service in Lancashire during the cotton famine, not as any acknowledgment of his successful sanitary work already described. Sir J. Bazalgette has also received the same distinction, and was knighted, if I am not mistaken, on the completion of his largest and most costly failure. I must add one more signal instance of long official neglect—the name of Dr. Farr, known and honoured by every zealous statistician and sanitary reformer throughout the civilised world.

But, generally, when I compare the rewards given for the intentional destruction of life in war, a process alas! dating very early indeed in the history of our race, with those given for the intentional saving of life by prevention, as distinguished from the cure, of disease, a process never systematised on any scale—indeed, hardly thought of, I may say—before the nineteenth century, I am painfully struck by the contrast. Not that I desire at all to detract from the praise or rewards bestowed on patriotic and effective service rendered to the country in war; but I think such victories of peace, conducing hardly less to the moral than to the physical well-being of man, ought also to have their fair share of national recognition and national gratitude. For example, the most brilliant sanitary service probably ever rendered was that performed by the First General Board of Health in repressing epidemics. This was remarkably attested by one of the Czar's physicians at the last Congress of Hygiene at Brussels. He there stated that in each successive outbreak of cholera at St. Petersburg treated on the old system, the loss of life had been from 23,000 to 25,000. He said it was to England they owed the effective prophylactic measures which had enabled them successfully to meet the next attack. It was the adoption of the practice elaborated by the First Board of Health of dealing with the premonitory symptoms that had reduced the mortality in that attack to $\frac{1}{4}$th of that in the previous ones. It was estimated at the time, on comparing the mortality in other places (and thus Russian evidence fully justifies the estimate), that 60,000 lives had been saved in England by the way in which cholera was there encountered. What would have been the reward if a similar loss of life had been inflicted on an invading army when repulsed with equal success from our shores? But what public acknowledgment was made of this signal, though peaceful service? What reward was given to those who had anxiously and laboriously rendered it? None! Again, when preventable sickness had done in the Crimea what the enemy's sword had failed to do, had destroyed our first army there, and the War Minister declared publicly that the application of sanitary science and the skill of the officers applying it had saved our second army there, and sent it back in better health than our army had ever had at home, what reward was given either to the devising heads or the executive hands that had wrought this change? Again, we must answer, None.

We are compelled to ask, after this experience of various successive ministries, Is saving life by preventive measures to be recognised as any service or not? Is it to have, as in the professions for destroying life, that acknowledgment of service rendered, which gives position and precedence at once to facilitate and to encourage men in rendering like service in future?

As it seems clear that sanitary reform, though commended in general terms, has not enjoyed, nor is likely to enjoy much official sympathy, and though praised in the abstract is always liable to incur Parliamentary and municipal opposition in practice, we must endeavour, now that pretty sound legislation upon it has been obtained, to influence as far as possible public opinion on behalf not only of its principles, but its details, co-operating heartily with the many societies and associations, to say nothing of the many private individuals, who have done so much to elucidate and stimulate an interest in the subject under its various aspects. We must try to enlist general administrative action in conformity with them; and in this term I would comprehend all administrative bodies from the Cabinet down to the school managers of the country parish: and not administrative action alone, but family action and personal action, and that not of the men only, but also—I may almost say mainly—of the women, and especially of the mothers. Not only is there nothing unfeminine in the action we ask of them, but it is pre-eminently in their own province, and essentially womanly.

And now let me commend to your sympathy and support a most valuable but unobtrusive Association, though enjoying the patronage of some of the highest in the land—the Ladies' Sanitary Association, which has enlisted among its helpers and counsellors various able and benevolent men, and among them the scientific, eloquent, and genial President of this Institute, but has never quitted its own modest sphere of work for one more ambitious or conspicuous. It is ready to co-operate with all engaged in the good cause, but its particular object is to diffuse sanitary knowledge and promote sanitary reform, especially among the poor; and it tries to do this very much, among other ways, by distributing plain little sanitary tracts among them; instituting mothers' meetings and classes of adult girls, and giving them sanitary and domestic instruction, and establishing nurseries for motherless babes, which may serve as schools for mothers of all classes, schoolmistresses, and nurses. It seeks to form branch associations. I trust that it will before long be able to count many.

I have trespassed already much too long on your attention. But I must remind you in conclusion that the cause of Sanitary Reform appeals not only to enlightened self-interest, but to our feelings of humanity and sense of religious duty. The law given by God to Moses comprised regulations recognised to this day as of great practical sanitary value, and our Divine Master and Great Example not only spake as never man spake, but showed His tender regard for the bodies as well as souls of men by going about doing good while upon earth, healing the sick, making the blind to see, and the lame to walk, and ministering to bodily wants and bodily suffering.

ADDENDUM.

THE question of the establishment of some complete representative local government for the metropolis has latterly attracted so much attention, and, thanks to the late Government's proposal for buying up the Water Companies, and the present Home Secretary's course in the Select Committee on that proposal, seems likely to attract so much more, that I have thought it worth while to reprint a few pages which I wrote upon the subject more than a quarter of a century ago, after several years' experience of local administration in the chair of the Metropolitan Commission of Sewers, as well as in the secretaryship of Poor Law Board, to say nothing of what I had gained as one of the chairmen of Quarter Sessions in Devonshire, and as chairman or vice-chairman for many years of the South Molton Board of Guardians.

'I find the necessity of special legislation, or rather of state regulation, for capitals as distinguished from mere provincial towns, to have been distinctly recognised when Constantinople became the seat of the Eastern Empire. For, as such, that city had many of its local concerns regulated by the Emperors Theodosius, Justinian, and others, in a series of laws hardly less exceptional and metropolitan in their character than those settled within the memory of men yet living, by the founders of the federal government for their new capital, Washington. Indeed, if it were my present purpose to establish the principle, I should feel bound to dwell at length upon the concurrent testimony of so many countries and so many ages.' 'But assuming the general principle to be admitted, keeping the political danger in view, and having regard to the necessity which it implies of so dividing and balancing municipal powers as to ensure their due subordination to the State, we will proceed to inquire how, in the organisation of our own capital, the vigour belonging to unity of administration may be combined with the constitutional advantages of local self-government.

'It seems to me that this can be done, but done only on one principle—viz., that of dividing the several functions or departments of government among separate and independent bodies, by extending the action of each over the whole area of the metropolis; instead of combining, as is the usual practice, all these functions under one body, and giving to that body, within a limited area of jurisdiction, supreme authority over all such matters. In each case, you will observe, there would be several governing bodies; but in the one case, each body would exercise *all* municipal functions within a *partial* area; while in the other case, each body would exercise only *one* class of functions over the *whole* area. In short, I propose that the Legislature should, for the management of the vast local affairs of the metropolis, establish in the shape of separate and independent bodies, that very division of labour which the municipalities of even the smallest boroughs have, in the shape of their separate Watch, Works, &c. Committees, everywhere long established for themselves.

'The categories under which municipal functions naturally fall seem to be the following :—

'1. Those relating to the regulation of works—such as water supply, sewerage, gas supply; the improvement and maintenance of thoroughfares, roads, pavement, &c., of the banks of the river, quays, and bridges; scavenging and the removal of nuisances, including the prevention of smoke.

'2. Those relating to the government of persons, including the administration of justice, civil and criminal, and the maintenance of public order and decorum; in other words, the direction of the police force; the protection of life and property, the detection, apprehension, trial and punishment of offenders; the management of prisons, to which I should add the relief of the casual poor, and the correction of professional vagrants; the control of lodging-houses; house-to-house visitation of the poor; the regulation of markets; the regulation of river steamers, cabs and public carriages, and of theatres and places of public amusement.'

'In each of these departments, inconsistencies of jurisdictions, incongruity of operations, and pecuniary waste would, obviously, result from any division of the area of administration.'

'Classing the above mentioned bodies (which we have assumed to be more or less representative in their character) as being respectively charged, the first with regulation of works, the second with the government of persons, it would seem desirable to create different constituencies, with different electoral divisions and different qualifications for each, in order to prevent their identity; the object being to weaken their influence if they sought to enter upon political questions, or to touch subjects beyond their own proper sphere.

'My experience, while guardian in Devonshire, for nearly fifteen' —now nearly forty—'years, and as secretary to the Poor Law Board for nearly three, convinces me that the presence in each body of certain permanent and more independent elements, analogous to the ex-officio Guardians, would much conduce to stability and continuity of policy, as well as to fairness of administration in many instances where, as in the case of the poor law, other interests besides those of the immediate ratepayers are concerned. While the experience of the poor law unions in general demonstrates that such a combination of different classes in one Board, far from realising the predictions of its opponents as to its probable aggravation of existing class antagonism, works well and harmoniously, and has tended to the promotion of mutual good feeling and confidence.'

'The obvious electoral divisions for the first body or board would be thus indicated by the natural drainage areas, irrespectively of political or other arbitrary limits. The separate areas for election would thus correspond, to a certain extent, with separate local interests, and with separate rates of payment, for general and district works, as under the Metropolitan Sewers Act, according to the different amounts of benefit received in each locality.'

'It would appear reasonable to include all ratepayers in this constituency; since all such are, as occupiers of houses, sufficiently interested in the proper drainage and water supply of their homes, and in the proper paving, cleansing, and lighting of their streets, to be willing to pay something for these advantages. At the same time, these settled but temporary occupiers of houses, being a decided minority of the population, are not by any means the only parties thus interested; nor are their interests in all respects identified either with those of the landlords on the one hand, or of the inhabitants at large on the other.

'The interest of the owner of the freehold (a class of which there are singularly few in London) is obviously that the structural arrangements on and about his property should be as lasting and good as possible; and it would in so far coincide with the interest of the population at large. But the interest, real or apparent, of the ratepayer, or temporary occupier, is, that the minimum of expense should be incurred during the period in which he pays rates, the permanent efficiency of the work being to him a secondary object.' 'And it has always appeared to me that, under the Municipal Reform Act, too large a share of power has been given to the ratepaying class, with too little protection both to the large and unrepresented majority below, and to the small and equally defenceless minority of owners above them in the social scale; and that much of the backwardness of our municipal Corporations in promoting sanitary improvement is attributable to this cause.'

'I should, therefore, propose that of the permanent members of the body entrusted with the structural concerns of the metropolis, a certain number, not exceeding one-third of the whole body at the utmost, should consist of the representatives of landlords, elected out of the landlord class independently of the ratepayers. One-third is, as your lordship will remember, the proportion of landlords admitted under the Irish Poor Law as ex-officio members in the somewhat analogous case of Boards of Guardians.' The representation of owners given in the Public Health Act of 1848 has long seemed to me one of its points of superiority to subsequent Acts. I have always contended that in England the ratepayers are over-taxed and over-represented.

'With regard to the next body, that charged with the duties relating to the police and internal management of the metropolis, it seems obvious that, as these functions concern less the natural features of the site than the artificial arrangements of man, the electoral districts should be formed in accordance with some pre-existing and well-known boundaries, such as those of the metropolitan parliamentary boroughs, or if they be thought too large, of the London unions, and large parishes under local Acts.

'The permanent members of such a Board would, from its connexion with judicial and quasi-judicial functions, obviously consist of magistrates appointed either directly or indirectly (through the Lord-Lieutenant) by the Crown; with the addition of some few other specially qualified persons, chosen by the Executive to watch over the imperial interests involved in the proper discharge of such duties, in regard to so vast a population concentrated round the seat of government. It is easy to see that, in the case of a body entrusted with functions already performed throughout London (except in the small jurisdiction of the City) by commissioners of police or magistrates under the direct authority of the Crown, the proportion of the representative element should, on every account, be much smaller than in the case of the Board last discussed. For, whereas there the popular element would preponderate greatly, here it should be considered rather as a modifying and harmonising element admissible only to the extent of one-third, or at the utmost, one-half of the whole body.

'But it is more difficult to say upon principle what ought to be the qualification of the constituency for the election of this representative element. That it should be such as to give a broad and popular basis to the elections, may, I think, be safely affirmed, seeing that not only the house renters, but even the lodgers in the metropolis are deeply interested in the due discharge of these duties. Indeed, it should not be forgotten that the aggregate payments of the lodgers constitute a large portion of the aggregate rental paid by the householders of the metropolis, and in a multitude of individual instances very far exceed it. My own impression would be that (excluding of course the usual disqualified classes of paupers and criminals) something like household or "pot-walloping" suffrage would be the most expedient, with the addition of all single lodgers qualified, either by paying a certain amount of taxes, or by receiving a certain amount of annual salary or wages, or by having passed certain educational or professional tests; or by having made a certain provision for themselves or for their families hereafter in the shape of so much deposit in the savings bank, or of membership for so long of a friendly society or provident association. This class of lodgers comprises many young single men of intelligence, prudence, and respectability,—many who form quite the *élite* of the labouring classes, and whose exclusion from a vote at these elections, supposing the householders admitted, would in my opinion not only cause just discontent, but also render the choice of fit men less probable.

'It is still more obvious with regard to the second body than the first, that very considerable powers both of superintendence and control ought to be reserved to the ministers of the Imperial Government; and that the paid officials should be all appointed, either directly by them, or at least with their concurrence. The chief appointments connected with the police, if the management of that force should be given to this Board, should be subject in like manner to imperial control. In short, the final and absolute authority of the representative body should be very much limited to the grant or refusal of the supplies demanded for particular purposes. Nor could this amount of restriction upon the popular will, in such matters, be reasonably objected to, when it is remembered that all the police rates, and the county rates for the maintenance of prisons, &c., are levied at present without consulting the ratepayers in any way whatever.

'It is obvious that, if considered desirable, several of the functions proposed to be included under the management of this one body might be taken off and given to some other authority, and the constitution of the Board might be modified accordingly. A much larger proportion of popular representatives ought, for instance, to be admitted into the Board, if, as might possibly [I should now say almost certainly] be thought expedient, the control and management of the police force (amounting to a small army in the metropolis), and the administration of justice, were still left, as now, to Crown-appointed commissioners and magistrates under the authority of the Secretary of State, instead of being, as in the City, vested in popularly elected authorities. But it would seem hardly possible for both these opposite systems of magisterial appointment and police management to be right, and the application of each to neighbouring parts of the same town expedient. Indeed, popular witnesses on the City inquiry, such as Mr. Travers, Mr. Elliott, Mr. Dillon, and Mr. Thomas Hankey confirm this view. And the testimony they bear to the superior working of the paid magistracy and of the general metropolitan police under the commissioners, as compared with that of the aldermen on the bench and the isolated City police, leave us no doubt which of the two systems ought to give way and be assimilated to the other.'

I further said that the house-to-house collection of voting papers 'has more than doubled the number of votes given, by affording opportunities of expressing their opinions, not only to many sensible and honest men, who otherwise would not have been able to vote at all, but also to many men not unfit for the franchise, who would not have been willing to make the sacrifice of time and trouble, or to undergo the publicity of polling in the ordinary way.

'It has been shrewdly observed that, especially in the middle and lower ranks, those who occupy themselves most about elections and politics are either the best or the worst citizens. The best take part in public affairs from a sense of duty, religious or patriotic; from a generous spirit of attachment to the person or the cause they espouse. The worst busy themselves in party contests, either from a love of the excitement, the conviviality, and gossip attending an election; or from the expectation of deriving advantages, in the shape of patronage or jobs, which more high-minded men would scorn. There is, however, a large intermediate class of men of average industry and character, who, caring much for their own interest and their families, and comparatively little for public measures or public men, can with difficulty be prevailed upon, however decided their preference, to support either one side or the other at the sacrifice of any of that time and trouble they value so highly, and know so well how to turn to account. So comparatively few of them go to the poll.'

The MAYOR, in proposing a vote of thanks to Earl Fortescue, said he was sure all felt deeply indebted to his Lordship, and personally he felt that the Institute had done Exeter honour in selecting it for a visit at so early a stage of its existence. Although some little difficulty had been raised to a proposal made that some members of the Institute should make a tour of inspection and report, yet he hoped that it would be found possible to meet the proposal, so as to give the city the advantage of their views.

The Bishop of Exeter, in seconding the motion, remarked that he could hardly conceive an address more suited to the purpose than that to which they had just listened. Personally, he had watched with the greatest interest the progress of sanitary legislation in this country, and he confessed that he had felt the greatest indignation when he had seen that something had prevailed other than true science, and that retrograde steps had been often taken which, when worked out, showed that the worst policy had been adopted. Nevertheless, it was undeniable that in the long run they generally learnt by mistakes, and the great value of Lord Fortescue's address would be in arousing them to consider what should be done in the future rather than in recalling the mistakes of the past. It was not possible to undo a great deal that had been done, but it was possible to follow better principles, to make them more generally understood, and to exercise an intelligent interest in people so as to make them see on which side they ought to throw their weight. His lordship advocated the throwing aside of mere crotchets, and he pointed out that the work was of especial interest to his own profession, inasmuch as soul and body were bound together, and if one was degraded, degradation must be caused to the other. Man rose in the scale of being as he was able to purify not only his soul but his body also, and to make it such as the Creator intended it to be.

The vote having been acknowledged by Earl Fortescue—who remarked that the best thanks of the citizens would be in their going through the town, seeing what was required, and getting it done—a vote of thanks was, on the motion of

Mr. Chadwick, C.B., proposed to the Mayor, and it was explained that the inspection of the town in a single morning—as had been suggested—would be impossible so far as obtaining sufficient information upon which to base a really valuable report was concerned. The way to get at defects would be for the members of the governing body to themselves visit a district immediately fever broke out, and then they would see the evil and be able to devise steps to meet it.

Mr. Robert Rawlinson, C.B., in seconding the motion, said that the members of the Institute came there not to glorify themselves, but to teach the citizens of Exeter anything in their power. This was the first time he had visited Exeter, and as one who had had perhaps as wide experience as anyone as an engineer, he might tell them that this was a city that could be easily and cheaply sewered, although in ignorant hands it might be very difficult and costly to sewer, and at the end they might be worse off than at the beginning. He understood that they had not yet begun the work, and he counselled them to get the very best advice before they did begin. Exeter was a town of 45,000 inhabitants; but if any engineer told them that the work would cost three times 45,000*l.*, they should not believe him, and should not accept his plans, because it was possible to carry out an efficient system of sewers cheaply,—sewers that would answer much better than those built at the sum he had indicated. Enormous amounts had been wasted in extravagant works, and enormous mischief had been done by works executed in a wrong manner. There were steep gradients in Exeter, and a man who sewered them must have a practical knowledge of what to do, or the rush of water would soon cut them up. It must be remembered, too, that gas flowed one way and water the other. Whilst the steep gradients would carry the floods rapidly down, gases would accumulate, and be forced rapidly up. There were towns in England which spent large sums of money in sewers, but the ignorant execution of the works simply raised the death rate of the towns possessing sewers of that character. He therefore, on the threshold, counselled Exeter to be cautious. They should get the best advice, and then set to work earnestly to carry out a proper system of sewers which would form the basis of house drainage. Here, again, it should be remembered that immense mischief was caused by the improper drainage of houses. Many houses were connected directly with sewers, were actually, indeed, the ventilators of these sewers, and the fact that more mischief was not caused than at present was due to the fact that every house was a ventilator, and so the poison was to a certain extent diluted. A house should be drained distinctly from the sewers—the house drains should be cut off effectually from the sewers, and there should be no possibility of sewer gas entering the walls of any human dwelling. If this principle was not adhered to, they would do mischief by sewering where they expected to do good.

The vote was carried *nem. con.*, and the MAYOR, in response, said he had no taste for visiting the fever dens of the city or anywhere else, as he had had a most painful experience of the evil caused by these diseases.

SECTION I.

SANITARY SCIENCE AND PREVENTIVE MEDICINE

SECTION I.

SANITARY SCIENCE AND PREVENTIVE MEDICINE.

The President of the Section, Professor F. de Chaumont, F.R.S., delivered the following address :

Ladies and Gentlemen,—My first duty to-day is to offer you a friendly greeting on the opening of the Section of Sanitary Science and Preventive Medicine; my second to tender my sincere thanks to the Chairman and Council of this Institute for having placed me in this honourable position. I hope I shall be able to justify their selection, although I know well that in an assembly like this a President's duties are light, friendly co-operation and not obstruction being our rule, even on those points where we must agree to differ; for in sanitary matters, as in other things, there are differences of opinion, and unfortunately often very serious ones.

Opening addresses have often been objected to, or at least their use questioned, especially when time is necessarily limited. I am quite ready to admit that if an opening address be of inordinate length it is an evil, and that it takes up the time which ought to be devoted to the papers and discussions. On the other hand, if it be kept within reasonable limits, I think it is well to mark in some such way the opening of the Section, and the occasion may be usefully employed in several ways. As I am addressing a mixed audience, to some of whom at least the subject is probably new, it may not be unprofitable if I explain what we mean by preventive or public medicine. This I will now do as briefly as I can. The word 'medicine,' like the word 'religion,' has had more than one meaning in its time, and even in the present day confusion arises, particularly when it is employed in an unfamiliar way. To the savage, medicine is synonymous with witchcraft; to the civilised man it often presents merely the idea of a drug, or, if it be used by extension to embrace the profession, the giving of drugs appears to be the most important part of it. But drugs may to some extent be called the opprobrium of medicine, as the knife is of surgery. For the highest medicine is that which obviates the use of drugs,—the highest surgery that which saves the limb, not that which lops it off. The Greek for a physician is ἰατρός, and this can be traced back to a primitive Aryan root 'yu,' which signifies 'to avert,' 'to ward off.' It is in this sense that we here employ the term 'medicine,' and public or preventive medicine is thus the science that wards off disease from the community. The expression 'state medicine' is also frequently used, meaning pretty much the same thing, and formerly the term 'medical police' was very commonly employed. Similar terms are or have been in use in most European languages. Attempts have sometimes been made to draw distinctions between those different phrases, but the necessity or utility of such refinements may well be doubted. It is well to recognise a general science of health preservation, which we may call sanitary science, or perhaps more conveniently hygiene, and of this there are several branches or divisions. Between those divisions no very hard and fast line can be drawn, although the differences are sufficiently defined for practical convenience. The arrangement of our Sections suggests one mode of division which is convenient. We devote one, the Section which meets here to-day, to public or preventive medicine, which may be looked upon as embracing for the most part the principles which are to guide us in our work. The second, which meets to-morrow, considers the questions of construction and engineering applicable to sanitary matters, and this may be looked upon as embracing the more important practical application of those principles. The third, finally, which meets on Friday, considers the questions of meteorology, geology, &c., those wider, and to us as yet vaguer influences, upon which, however, doubtless depend many things of the highest importance in connection with the health of man. Leaving to my learned colleagues, the Presidents of the other Sections, the task of commenting upon their own particular branches, we may turn our attention for a few minutes to our special Section. This, as I have said, is more especially connected with the principles of hygiene, or sanitary science; but it would be a grave mistake to suppose that it is only theory that we deal with. We have to go into many practical points as well, and especially to bear in mind that it is the practical application that makes principles important to humanity. A knowledge of what is good and true is of little use if our lives are false and our deeds are evil. The highest abstract conceptions of the beautiful are nothing if our work in the concrete breaks every law of form and harmony. We must insist upon our philosophy bearing fruit, as Bacon did with his, and if our tree does not bear fruit, it had better cease cumbering the ground. Sanitary questions, in one form or another, are of very old date, and many of the earliest writings are occupied with rules and instructions as to how health is to be preserved and plagues are to be avoided. Advantage was taken in many cases of the superstition of the people, when the more enlightened rulers sought to enforce those rules and practices by giving them the sacredness of religious observances; in fact, making their discharge a *religion* or outward sign of the faith they professed. In matters of practical sanitation the ancients were in many things in advance of the moderns. The hygiene of both cities and camps was understood to a remarkable degree, whilst the habits of personal cleanliness, and the healthy outdoor lives most men led, no doubt greatly conduced to the well-being both of the individual and the community. Although we read of plagues and pestilences from time to time, it is not until we have passed the Christian era that we begin to encounter those appalling pestilences that so often struck terror into the heart of Europe, and made its wretched inhabitants think the end of the world was at hand. The fall of the Roman Empire was in a great measure the era of retrogression in a sanitary sense, although it may have had its advantages in other ways. It may shock the feelings of some, but it must be admitted that the progress of Christianity had an evil influence on the sanitation of the world. It so happened that both pagan and Jew were clean, and the Christian could think of no better way of testifying his opposition to both than by doing the reverse of what they did. Therefore the more fanatical ceased to wash either person, clothes, or dwelling, because pagan and Jew cleansed all three. Dirt became the odour of sanctity, as the hideous tales of St. Simeon Stylites and other unsavoury fanatics only too truly tell. The baleful influence of those misguided views continued to be felt through succeeding generations down to our own day, and it may be a question whether we do not owe some forms of malady at the present time to the effects of the accumulated filth of ages. Our learned friend, Dr. Richardson, has called attention to the remarkable immunity from epidemic disease enjoyed by the Jews, who have continued to practise those purifying observances handed down to them in the law of Moses. Let us hope, however, that if a sad recoil took place at the beginning of our era, it was one to be followed by a more vigorous bound forward in the time to come, according to the French proverb, *Reculer pour mieux sauter*, and that if we have not yet got rid of dirt altogether, we at least *know* that it is matter in the wrong place, and may set ourselves to place it rightly when opportunity presents itself.

I have said that the study of sanitary matters was a very old one, but I guarded myself from using the expression sanitary science, for in truth the sanitation of former times was almost, indeed we may say altogether, empirical. It was through experience merely that effects and causes were rudely connected together, but anything like proper generalisation was wanting. It was as if it had been experimentally ascertained that an incandescent object would generally burn, and a man were to lay hold confidently of a bar of hot iron because it was not actually in a glow. The obstacle to progress lay in the imperfections of the sciences generally, which thus made anything like a scientific study of disease-causes an impossibility. Superstition of all kinds was also so much mingled with all inquiries that the collection and grouping of observations was an extremely difficult task. The question is, how far have we advanced out of this condition in the present time? Are we really entitled to speak of sanitary science or a science of hygiene? Have we emerged from the empirical epoch? I am afraid that we must admit that we have only very partially done so, and that to a large extent we have done little more than remove the supernatural from our list of causes. We are still very much in what Comte calls the 'metaphysical' stage of the question. It may seem a contradiction of terms that I should in one breath speak of the question as 'empirical,' and in the next 'metaphysical,' but it is really not so. 'Empirical' is 'experimental,' but not experimental in its best sense, and hence 'empiricism' has become synonymous with charlatanism. It is at best working by experiment, but in an unintelligent way, either looking no further than the present fact, or else applying to the observed fact a crude and ill-digested generalisation. In this way empiricism, experimental though it be, is well calculated to lead to metaphysical views of things, meaning by that, views which tend to throw the efficient cause back into transcendental operations, which merely form a cloak for pretentious ignorance. In saying this I have no particular views or theories in my mind that I propose to gird at; *mutatis mutandis,* the same principle might be applied to all the sides of the question. But how, then, are we to have a real science of preventive, public or state medicine? Is such a thing possible, or is it merely a fond dream? If we look at the opposite opinions held and theories urged by men of long experience and knowledge, it must be confessed that there is some reason for discouragement. Sanitary science can only advance as medical science proper advances, and by medical science we mean especially diagnosis, pathology, and etiology: that is, the correct recognition of disease; its history and description as revealed by researches both in life and after death; and lastly its causes, proximate or remote. In the two first branches the forward progress has been in modern times extremely rapid, and in many directions highly satisfactory. Of the last, the determination of the causes of disease, I am afraid I cannot speak with so much confidence, although we have made some advance. But it is upon this very branch of the subject that the advance of sanitation towards the dignity of an exact science depends. Until we know more of the causation of disease, it is impossible to lay down rules for its prevention. But because progress is slow, are we to despair? Certainly not. The only way to effect progress is by careful observation and recording of facts, having full faith that the day will assuredly come when those facts will range themselves in proper order and reveal the hitherto unknown law that binds them together. But each fact must be the truth, so far as we can make it so, and its bearing must be measured and its value weighed. The word 'medicine,' from the Latin 'mederi,' is traceable to an Aryan root 'mêdh,' or 'mêd,' which means 'to know'—'to understand;' that is, not merely to be a storehouse or lumber-room of isolated facts, but to be, if possible, a properly classified museum, in which each is arranged according to its correct natural affinities. Curiously enough, etymology carries us still farther back into the morning of our race, and shows us that the root 'mêdh' was connected in a far earlier time with the root 'madh,' to measure—a root which we find in *mathematics*, *moderation*, and in *measure* itself. It would seem that those two roots became early separated, just as medicine and the science of measurement, or mathematical precision, have been so long divorced. It is the province of our age to bring about a reunion of those two, which have been too long estranged. The more the science of measurement, in its widest sense, has been applied to biological inquiries, the more it has been seen that all nature is obedient to fixed laws, and we need have no fear that that part of biology which has to do with the causation of disease is in any way an exception. The Greek myth which made the Goddess of Health the daughter of Esculapius, the typical physician of the heroic age, contained a germ of truth which could be appreciated only in later times. Another story makes hygiene or health an attribute of Minerva, indicating that upon wisdom or knowledge all health depends. Let us hope that in this case wisdom may be justified of her children.

F. de Chaumont, M.D., F.R.S.

President of Section.

On the conclusion of Professor De Chaumont's address, Lord Fortescue proposed a vote of thanks to the President of the Section for his lucid and interesting remarks.

Dr. Carpenter (Croydon) said he had very great pleasure in seconding the vote of thanks proposed by Lord Fortescue. The address showed deep thought, and he trusted that the subject matter of it would sink deep into the hearts of those who heard it, for it would lead them to believe that there was a future in connection with sanitary science that would bring its own reward, and that the city of Exeter might receive some benefit from what was now taking place in its midst. He was sure the address would be a marked one in the history of the Congress and the Institute.

The vote was carried *nem. con.*, and was acknowledged by the President.

Exeter Sanatorium, with a Few Remarks on the Importance of Early Isolation of Cases of Zymotic Disease.

Exeter having been one of the earliest towns to provide a hospital for the reception of cases of infectious disease, I have thought a few remarks on the subject, with a short account of the Sanatorium and the patients treated there, might not be unacceptable to you on this the first occasion of the Sanitary Institute holding its Congress in the 'ever faithful city.'

The Town Council of Exeter became the Urban Sanitary Authority by accepting the Local Government Act in 1867. But, previous to this, on the approach of the cholera epidemic of 1866, they appointed an Inspector of Nuisances (Mr. Stear) and formed sub-committees, who made a house-to-house visitation; and in conjunction with the district medical officers, considerable sanitary improvements were carried out. House drains were examined and repaired; privies changed into water-closets; cesspools closed; new water-closets compelled to be erected, where required, with proper connection with the town sewers; water-cisterns were cleansed and numerous new cisterns ordered, at a considerable cost to owners of small houses.

The guardians of the poor engaged extra medical men to act as assistants during this epidemic, which, although severely felt in Exeter, would undoubtedly have been far more fatal had these steps not been taken. At this time, the first attempt at providing a separate place for the reception of cases of infectious disease was made by the removal of a few cases, occurring in common lodging-houses, to the workhouse, where a couple of rooms, isolated from the house, were used for this purpose. The cholera passed away, and with it a good deal of the sanitary activity. But in 1871, when an attack of small-pox threatened the city, the Town Council determined to build a small-pox hospital, or, as they, I think wisely, called it, a Sanatorium; and after some considerable difficulty, owing to the unwillingness of owners to sell land for this purpose, they secured a very eligible site—a field of an acre and a quarter, with a small cottage, in the parish of Pinhoe, close to the hamlet of Whipton, on the top of a hill, and only a mile and a half from Exeter.

Here they built (of necessity hastily) a wooden building, with four wards—two 24 ft. square, and two 20 ft. by 24 ft.—with a nurse's room between, whilst a covered way joined it to the cottage, in which cooking, washing, etc., were done; the hospital being capable of accommodating twenty-eight to thirty patients, and being heated by Gurney's stoves.

It was opened on November 2, 1871, and during that year and 1872 and 1873, seventy-nine small-pox patients were admitted, viz.:—

		Recovered	Died
Vaccinated	62	60	2
Not vaccinated . . .	17	12	5
Totals . . .	79	72	7

In 1873, 1874, and 1876 (there were no patients in 1875) a few cases of typhoid fever were admitted, viz.:—

		Recovered	Died
Typhoid fever	28	22	6

But up to 1877 the building had been considered as a small-pox hospital, to be used, perhaps, occasionally as a fever hospital for cases that could not be treated in their own houses, but not as an institution to which all cases that could not be properly isolated in their own homes should be taken, so as to stamp out, if possible, zymotic diseases at their commencement.

Unfortunately for the immediate success of this principle, scarlet fever had spread itself very considerably before it was adopted, as will be seen by the admissions in 1877, which were:—

		Recovered	Deaths
Scarlet fever	80	74	6
Typhoid fever	14	13	1
Totals . . .	94	87	7

Early in January 1878 small-pox in a very severe form was brought to the city from London by some young women engaged in the Christmas pantomime. But by promptly removing the cases to the Sanatorium, and thoroughly disinfecting the rooms, burning or disinfecting clothes, bedding, &c., and revaccinating all persons who had come in contact with them, the disease was soon eradicated. The number admitted in January was—

		Recovered	Deaths
Vaccinated	7	7	—
Unvaccinated	5	2	3
Patients who caught the disease whilst in the Sanatorium (vaccinated)	5	5	—
Totals . . .	17	14	3

At this time there were several cases of scarlet fever in the building; and although the small-pox patients were placed at the other end, and those convalescent revaccinated, yet, owing, I conclude, to the partitions not having been carried quite up to the top of the roof, five patients caught the small-pox. All, I believe, had been vaccinated in infancy, and none had the complaint severely, or were at all marked by it.

This occurrence, however, called attention to a defect in the building, which had been hastily run up for a small-pox hospital only. The wooden walls were battened, and the space between filled in with sawdust, the partition carried up to the roof, and the wards entirely separated from each other.

But not content with this, the Town Council have built an entirely new permanent brick and stone building, consisting of two large wards, each to contain eight beds, with baths (hot and cold), nurses' rooms, etc. This is quite detached from the old building, and will be used when required—*i.e.* if we should have cases of two separate diseases. Some difficulty has been found with regard to water supply, but that has been met by large rain-water tanks for washing purposes, and a deep well (151 ft.) for drinking water. Earth-closets are used, and excreta, etc., are buried. The usual outbuildings are provided. I need not weary you by further details of cases, which are all given in a schedule appended; but I may state that now every case of small-pox, typhoid or scarlet fever occurring in the city which from any circumstance cannot be properly and thoroughly isolated where it is, is, on the order of the district medical officer of health, at once removed to the Sanatorium.

There is a nurse (Mrs. Manley) who resides at the cottage annexed, and extra nurses are engaged as required; whilst the medical attendance is undertaken by my colleagues, Messrs. Bell, Brash, and Harris, and myself, each of us taking it in turns to attend monthly.

The Sanatorium has now been open just nine years, and during that time the number of admissions has been :—

			Recovered	Deaths
Small-pox	Vaccinated	74	72	2
	Unvaccinated	22	14	8
		96	86	10
Scarlet fever	. . .	97	91	6
Typhoid fever	. . .	108	93	15
Measles	. . .	9	9	—
		310	279	31

This result may be considered highly satisfactory, 310 cases with only 31 deaths or 10 per cent. being, I believe, much below the average. The sanitary inspector (Mr. Lendon) is provided by the Town Council with a roomy carriage (formerly a cab), which has a board and cushion fitted across one half of it, so that children can be laid quite down, and adults nearly so, in transit. This is disinfected after being used, and it can be obtained by any one requiring it on application to the sanitary inspector. An ambulance carriage has been thought of; but, at present, there is this objection—in removing all cases it is important to do so quietly and without calling particular attention to the fact, whereas a distinctive carriage being seen in the street would excite remark, and lead, if not to a panic, at least to an exaggerated report of the number of cases removed to the fever hospital. At first we had some difficulty in persuading people to let their relatives be removed, and as it was out of the city it was not until the Exeter Town Council got (in 1875) an amending clause inserted in the Act giving compulsory powers to send not only to a hospital within their jurisdiction, "*but within a reasonable distance*," that we could legally compel the removal. This has, I am glad to say, seldom been required, as year by year the patients appear to value more and more the healthy situation, the fresh air, and the care with which they are treated. The advantages of compulsion, etc., were never better shown than in the case of a laundress (in S. Sidwell's parish) who was ironing clothes in the room in which one child was running about in the skin-peeling stage of scarlet fever, whilst another was lying on two chairs covered with the rash, clothes drying hanging all around him. The mother denied that they had the scarlet fever, and refused to let the children be removed. The magistrates, however, ordered the immediate compulsory removal of the children and the thorough disinfection of all the clothes. It is fearful to think of, what mischief this might have caused had the case not been discovered when it was, as in the ordinary course the clothes would have the same evening been distributed all over the city. In alluding to the effectual stamping out of small-pox in January 1878 (since which date no cases have occurred in Exeter), it is only fair to the public vaccinator (C. H. Roper, Esq.) and the vaccination officer (Mr. C. Ashford) to call attention to the efficient way in which the vaccination of infants is performed in this city; whilst it is chiefly owing to the trouble taken by the district medical officers of Exeter (Messrs. C. E. Bell, E. A. Brash, and J. D. Harris) that cases of infectious disease are discovered *at their commencement* and removed to the Sanatorium. Knowing that one fact is worth a hundred assertions, I hope these few particulars may induce many other towns and districts to follow our example and establish hospitals for infectious diseases. It cannot be too much impressed on the public that all zymotic diseases *are, or ought to be, preventable.* This is generally allowed with regard to scarlet or typhoid fevers, but it is not equally known that measles and hooping cough are not *necessary* diseases *which every child must have*, or we should not find mothers and nurses taking children to catch measles, because "*this is such a good sort.*" With regard to elementary schools, I believe they are a source of the spread of these diseases more often than is suspected. Instead of the teacher making due inquiries as to the cause of absence from school from illness, and if found to be of an infectious character not allowing the brothers and sisters to attend the school for a time, too often, in order to keep up the average attendance, or to swell the number at the examination and so increase the grant, children are allowed to come daily from houses where some are suffering from these diseases, which thus become spread far and wide through the town. It is but fair to state that in some schools a very different mode is adopted, and all that can be done is done to prevent any infected children coming to the school.

CASES TREATED IN EXETER SANATORIUM

From Nov. 2, 1871, *to Sept.* 22, 1880

Date	Small-pox: Total number	Small-pox: Vaccinated	Small-pox: Not vaccinated	Scarlet fever	Typhoid fever	Measles	Recovered	Deaths	Remaining at end of each year
1871	14	10	4	...	...	...	9	1 (n v)	4
1872	24	20	4	...	...	...	4 22	2 (1 n v)	...
1873	41	32	9	...	...	...	37	4 (3 n v)	...
"	...	...	...	...	7	...	6	...	1
1874	...	...	...	...	13	...	1 10	3	...
1875	...	...	...	...	...	...	...	...	...
1876	...	...	...	..	8	...	3	3	2
1877	...	...	...	...	...	...	1 (T)	1 (T)	...
"	...	...	...	80	...	...	61	6	13
"	...	...	...	...	14	...	12	1	1
1878	...	...	...	...	...	...	13 (S) 1 (T)	...	...
"	...	...	...	...	25	...	23	2	...
"	...	...	...	15	...	...	14	...	1
"	12	7	5	...	...	...	9	3 (n v)	...
"	5*	5*	...	...	...	...	5	...	...
1879	...	...	...	...	...	...	1 (S)	...	...
"	...	...	...	2	...	...	2	...	...
"	...	...	...	...	29	...	19	4	6
"	...	...	...	...	...	2	2	...	...
1880	...	...	...	...	...	...	6 (T)	...	...
"	...	...	...	...	12	...	11	1	
"	...	...	...	...	...	7	7	...	...
	96	74	22	97	108	9	279	31	

* These five patients were admitted with scarlet fever, and caught small-pox in the Sanatorium.

ANALYSIS.

Total number of patients 310, including 5 counted twice, who had scarlet fever and then small-pox.

		Recovered	Deaths	Total treated
Small pox — vaccinated . .	74	72	2	96
Small pox — not vaccinated .	22	14	8	
Scarlet fever	97	91	6	97
Typhoid fever	108	93	15	108
Measles	9	9	...	9
	310	279	31	310

Because I have not in this short paper alluded to drainage, water supply, etc., it must not be imagined that I do not appreciate their value; but whilst too much importance cannot be put on having pure air and pure water, still, as with the present facilities of locomotion it is impossible to prevent the introduction of infectious diseases, it is to isolation we must principally look to check and stamp out zymotic disease when it *first* shows itself, and this, I believe, it is impossible to do without—

First, a proper hospital or building being provided by the sanitary authorities; and secondly, a compulsory notification of each case of infectious disease. The onus of this should rest on the parent or householder, and *not on the medical attendant.*

The plan I would propose is that each householder, etc., should be bound under a penalty to inform (within so many hours) the local sanitary authority of any case of infectious disease occurring in his house, and I would further oblige (also under a penalty) the medical attendant to inform the friends of the patient as early as possible that he was suffering under an infectious disease, giving name, etc.

In each district the name of the person to whom notice should be given, with a list of the diseases to be reported, should be freely posted, all communications to be strictly confidential, and, if desired, visits, at first at least, to be paid after dusk, or report to be accompanied with a certificate from the medical attendant stating that proper isolation and disinfection are being efficiently carried out.

John Woodman, F.R.C.S. (*by Exam.*),
Medical Officer of Health, City and County of City of Exeter.

Mr. Henry C. Burdett said that the people of this country did not like too much motherly legislation; but it was unquestionable that legislation should compel people to do their duty towards their neighbours in sanitary matters, for the spread of fatal diseases was too often owing to the neglect of sanitary precautions. The best way to educate the public in health questions would be by insisting upon health laws being carried out, and this insistance would keep before the minds of the people the duty which all members of society owed to each other. One necessary though lacking piece of legislation was that compelling the notification of cases of infectious disease, for the registration of diseases would be a great check to infection. The onus of this notification should be thrown upon the householder. True legislation was based on the greatest good of the greatest number, and the effective registration and the reporting of infectious diseases should be made compulsory by law, upon every householder, of whatever rank or position. It was part of the scheme of the Home Hospitals Association in London to provide cottage hospitals for infectious diseases—hospitals in which the patients would be attended by their own medical men. To show that medical men recognised the importance of isolation in such cases, he might mention that a medical officer of Guy's Hospital had had his own wife removed to an infectious hospital in a case of fever. The hospitals of the cottage character could be maintained by subscribers, the subscribers having the first opportunities of using the institutions in case of necessity. The Sanitary Institute must be indebted to Mr. Woodman for having brought out instances of the advantage of isolation in the treatment of infectious disease.

Dr. Bond (Gloucester) had found in his own experience that one of the stock objections to the erection of such hospitals as that just described by Mr. Woodman was, that you may provide the hospital but you cannot get the people to go into it. At Cirencester there was a hospital, with ten beds, provided by Cirencester and Gloucester in conjunction. As a matter of fact, it had been made very considerable use of, but a large proportion of the patients were children; indeed, the children were made so thoroughly comfortable that they were really unwilling to leave. There was no foundation whatever for the very prevalent prejudice which asserted itself, and caused in some cases a disinclination to go into these hospitals.

Mr. Domville pleaded the local character of the paper and its interest to Exonians as his excuse for intruding upon the section in order to take exception to one or two so-called truisms. He congratulated Mr. Woodman that he had signed his paper as 'Medical Officer of Health for the City and County of the City of Exeter;' and he trusted that this would go forth as a fact, and not as a theory, for in the Exeter Town Council the other day, on asking if a certain matter had been referred to the Medical Officer of Health, he was met by the assertion that there was no Medical Officer of Health for the city, and that it was hoped that the city would never be under one. A Medical Officer of Health would be more efficient if he were untrammelled by the necessities of his private practice. It was absolutely necessary that there should be a Medical Officer of Health for a city like Exeter, with the entire services of an efficient man, and this point had a much wider bearing than they were at first willing to admit. The present medical arrangements at the Sanatorium were unsatisfactory. The advantages of the Sanatorium would be increased twenty-fold if it were removed from the charge of three or four medical men in practice in the city, handed over to one man who was not a competitor in practice, and freely opened to all medical men, who would thus be able to induce patients of the higher classes to go there, on the assurance that they would not have to be attended by a practitioner other than their own medical man. Then, too, he had to remark, that schools, in these days of examination, were not only hotbeds of infection, but in too many cases the pressure brought to bear to compel children to attend the examinations was productive of immense evil. It should be the bounden duty of the teachers in such cases not to compel the attendance of children in the schools, but absolutely to prohibit it. He mentioned, without disrespect to the Medical Officer of Health, that in Exeter it had been stated that the Inspector was the more competent to pass an opinion whether the children should attend. Then it was necessary there should be a proper ambulance provided. At the same time there was a strong opposition to the use of any distinctive vehicle—one which savoured of the prison van. If members of the Congress could help to the designing of an unrepulsive pattern vehicle, in which the patient could lie recumbent, they would enable the medical men of the city to carry out the principles of the public health.

Mr. Robins inquired whether 'Sanatorium' was to be the name of fever hospitals or convalescent hospitals?

Dr. Carpenter congratulated Mr. Woodman on the fact that the Sanitary Authority had the control of the Sanatorium and not the destitution authorities—the guardians. Where the isolation of the sick had been done under the latter authority, it had frequently been very injurious to the suppression of disease, because people would not go into the buildings supervised by Boards of Guardians, under the impression that they were thus being pauperised. By stamping out disease in the first instance, its development in private houses would be prevented. The Sanitary Institute was anxious to impress upon the people that there were sanatoriums and sanatoriums, vaccinators and vaccinators. If vaccination were properly performed, there was no doubt that the number of cases of small-pox arising in the district in consequence of exposure would be proportionately small. Vaccination was performed much more efficiently now than it was twenty years ago, and it would be found, on an examination of small-pox patients, that the children who had been vaccinated were absent. Mr. Domville had impressed on the meeting the necessity of Medical Officers of Health being untrammelled by private practice; and this might be said without disrespect to Mr. Woodman, if the large city of Exeter could see its way to such an appointment, as it was human nature that other medical men would not be anxious to get Mr. Woodman introduced into families which they were attending. The course suggested by Mr. Domville would, therefore, be advantageous to the community. The speaker trusted that the people would not be slow to take advantage of this sanatorium, the existence of which rendered aid to those whose duty it was to stamp out disease.

Mr. Stephen Bourne remarked that the difficulty with respect to schools might be got over by the aid of the Education Department, if the days when the children were unable to attend in consequence of sickness were reckoned in the days requisite to qualify the children for presentation for examination. The qualification was merely for presentation, and did not carry with it any results unless the child was able, by intelligence, to achieve them. A proper representation to Mr. Mundella would doubtless effect an alteration in the code of regulations.

Dr. Richardson suggested that Mr. Bourne should draw up a resolution for consideration at the Council Meeting on Friday.

Mr. White stated that he had just pencilled out a resolution, and promised he would subsequently submit it. He referred to a small Cottage Hospital in Hampshire, in which the rule was that one medical man should supervise it, but that each patient, coming from all the villages around, should select his own medical man. This rule had been one great means of inducing the people in the neighbourhood to come into the hospital, because they would not be restricted to the attendance of one medical man.

Mr. Woodman, in reply, said that, as one of the Medical Officers of Health, it was not for him to say whether his position was good or bad. The Exeter Hospital was generally called the 'Sanitarium,' but was more frequently spelled the Sanatorium. If it had been in the first instance called the Fever Hospital, or a Small-pox Hospital, they would not have got the patients to go there. In 1880 there had not been a single case of scarlet fever received into the Sanatorium, and he believed that there had been only one isolated case in the whole city. It showed that the Sanatorium had been a step in the right direction. A very large number of the modern cases of small-pox showed marks of very imperfect vaccination; and, as far as death prevention went, vaccination had proved very successful, and when cases had occurred, they had been of a mild character.

The PRESIDENT concurred with Mr. Domville, and added that a Medical Officer should be so far independent of the authorities that he could not be removed at caprice. Referring to the use of the term Sanatorium, Houses of Recovery, &c., he pointed out that until the public had become more enlightened, these little subterfuges would have to be resorted to. On the subject of registration, he mentioned that last year, at Amsterdam, he had seen the course adopted in Holland. The inhabitant householder, as well as the medical man, had to give notice of the occurrence of infectious disease; and, if there were not means of isolation, the patient was sent to the public hospital. If there were any objection to that course, the house was put into quarantine, and placarded, 'This is an infected house,' with the nature of the disease; and no business was allowed to be carried on in the house where infection existed. Holland was not a despotic country, but with parliamentary legislation and freedom like England. In England, therefore, there ought not to be any practical difficulty in the adoption of a similar course, without which we should never satisfactorily be able to cope with infectious diseases.

Notes on the Spread of Diphtheria.

THE prevalence of Diphtheria, ever since the beginning of the sixteenth century, in every region of the old and new world—its large proportional fatality, its probable recurrence in the same individual, the hereditary susceptibility to its attacks, the rapidity with which it often strikes down its younger victims—the hidden pathways along which it glides from one home to another, passing by the hovel where sanitary neglect seems to claim it as an expected guest, and knocking with a hand which admits of no denial at the cleanest upland homestead—fix the attention of the student of preventive medicine, and render its etiology a matter of no slight interest.

The noble Washington, the historical Empress Josephine, our own well-loved Princess Alice, are counted among the numbers it has slain.

That one sick child may infect an entire household; that its poison may be smuggled in clothing; may be meted out by our milk-man in his daily rounds; may steal on us shrouded in the gases of our sewers; that it may cling to the floors and walls of empty chambers for days or even weeks—are but too well recognised facts. Indeed, I remember where within one of my sanitary districts the farewell kiss impressed on a coffined corpse proved the kiss of death to a group of unsuspecting Sunday-school children.

Neither the season of the year, nor excess or deficiency of heat, bear any relation to the spread of Diphtheria, and its connection with rainfall is assumed rather than proved. If we extend our inquiry into the propagation of Diphtheria over any wide area, we shall soon observe that the majority of those suffering from its attacks are children, and that the most impure and over-crowded habitations quite as often escape as the cleanest and best ventilated; in fact, that it is not on sanitary conditions that, at all events, its primary visitation depends. No doubt that when Diphtheria is once fairly established among a swarm of ill-fed, close-packed, unwashed youngsters, they will die faster and spread infection further, than more fortunate children; but these are only the accidents which result from overcrowding, want of control, bad nursing, and all the attendant ills of thriftless poverty.

But the isolated position of a house, and its distance from an infected centre, render it no more secure from the advent of Diphtheria, than the cleanness of its surroundings might be expected to do. This disease leaps with long strides from one dwelling to another, miles apart, leaving the inhabitants of the intervening hamlets and cottages untouched. The only reasonable explanation seems to be that the atmosphere becomes contaminated by contagia from the bodies of the sick, and that currents of air carry the poison with them in their course. Bretonneau, indeed, opposes to this theory the weight of his great authority, for he says, 'it (Diphtheria) no more possesses this property than the syphilitic disease does.' And in another place, 'The facts supplied by the epidemics of diphtheria which have broken out in the department of Indre et Loire, or which have extended into the surrounding departments, prove in the most evident manner that the atmosphere cannot transmit the contagion of Diphtheria.'

William Squire, however, admits that, to some extent, the material of infection must be diffusible in the air, and that within the limits of a house the danger of infection is greater from this source than from direct contagion.

I venture to think that he understates the facts, and that the miasm of Diphtheria travels far along the course of prevailing winds. I relate the following as an illustrative case :—

On the morning of June 6, 1879, the household of a farmer living at Warnscombe Farm, North Devon, were in perfect health. Their milk supply was derived from their own healthy cows; their drinking water was excellent; they used neither drains nor cesspits, simply a detached earth closet. The building stands more than a mile from any other, on the sloping side of a grassy hill, commanding delicious land and sea views, and is blown on by every wind except the north-east. Three of the children were absent from home for a few hours on this day, walking a distance of a mile or so towards the sea-board, and returning home direct—neither entering a dwelling-house nor conversing with strangers. At nightfall, two of them complained of illness. The next morning Diphtheria was recognised by their medical adviser, and on the fourth day the youngest, aged seven years, died. The illness was made known to the local sanitary authority from the commencement; and, in conjunction with the medical man in attendance, the most stringent precautions were used to limit the spread of infection—providentially with good success. I instituted a most searching inquiry, both within my own sanitary districts which surround the house and in the adjoining parishes, to discover a source of infection, and could find none nearer than in a village eight miles away, where, in a detached house, two cases of Diphtheria had occurred not long before. The tenant of Warnscombe, a most intelligent yeoman, who took the greatest interest in the matter, assured me that there could have been no possible intercommunication.

The behaviour of Diphtheria during an epidemic which occurred at Ilfracombe in 1873–4 affords a further illustration of its aërial spread. Certainly for ten years previously, and probably for a much longer period, no case had been noted in the town or district, when, on April 21, 1873, the death of a child aged 4 years was registered as 'Diphtheria, membranous exudation on the fauces,' thus leaving no doubt of the nature of its illness. The house in which the child died is a small hotel, a few feet above the sea-level, situated in a very sheltered position, adjoining the poorest and most crowded part of the town. No special sanitary precautions were used except the separation of other children and the rest of the household from the sick child. The windows of the room in which it lay were closed, certainly through no theory of air infection—and ventilation was carried on by means of the upcast draught of a wide open fire-grate. The corpse was early placed in a secure coffin and buried. More than six months passed by, and no fresh case occurred.

In the following November there were some cases of Diphtheria on board a training-ship in a distant port, and a lad named Prust, aged 13 years, was sent home ill to Ilfracombe. He was received by his aunt, housekeeper to an elderly lady, who resided in a large roomy house, part of a terrace overlooking the town some two hundred feet above the sea level, and open to the fields front and rear. A medical man, who chanced to live next door, was called to see the boy an hour or two after he came home, and recognised Diphtheria. On the third day the lad died. His aunt,—'to avoid making a fuss,' as she called it, and dreading her mistress's displeasure on her return home—neglected every sanitary duty, aired the sick chamber with open windows, and removed the corpse on the evening of death to a relative's house, in a hastily-constructed shell.

This house was unfortunately nearly the highest in the town. Twenty-four hours had hardly passed before two of its inmates, young children, were infected. They were carefully kept within doors, and all communication with the outside world prevented so far as might be.

Four days afterwards, three children, aged 4, 5, and 8 years, living half a mile west, straight down the course of the then prevailing wind, were fatally attacked with Diphtheria. The same medical man was not in attendance on them; the milk supply was separate; and their isolation was satisfactorily proved, as they were just recovering from measles, and had not quitted their own roof for the previous three weeks, except to take an airing in the garden. In fact, the medical certificate of death in the case of the first child is 'Measles—Diphtheria.'

In a day or two more, the children of a country wheelwright were attacked, three fatally, with the same disorder. His house is two miles from the town; is isolated on the top of a blowy hill (700 ft. high) surrounded with upland pastures, sloping down to the coast-line. During a portion at least of the preceding week the wind had blown in the direct line from the home of the last group of cases over this man's house. Two of his children, aged 2 and 4 years, were out of doors, well enough, in the daytime, and were attacked in the evening with hoarseness, pain in swallowing, swelling of the throat and palate, 'primary laryngeal Diphtheria,' and died within a few hours of each other.

From these multiplied centres of infection the disease spread. To check all communication from house to house was impossible, and by the time this outbreak had ended, more than 125 cases had been under treatment, and thirty-two children had died.

Now in the case which occurred in April 1873, it is true that no great attention was given to sanitary and preventive measures, and I am informed that the only antiseptic treatment adopted was the local use of potassium permanganate; still, from the *low level* of the dwelling-house, its very sheltered position, the almost accidental closure of the windows, and the early sepulture of the body, the germs of the disease could not mingle, to any great extent at least, with the currents of the air, and the poison failed to spread.

But no sooner had diphtheria been imported into a house *on a high, exposed situation*, and the corpse been carelessly moved from place to place, than clouds of disease germs were set free into the air; were driven down the wind, and soon found their way on to the mucous surfaces of children.

It will be observed that in the three examples of supposed aërial infection separate groups of children were attacked together, group by group, and that at least in two instances local lesions were first noticed, and were prominent till death took place. In fact, the relatives described the children's illness by using the expression 'that they were suddenly struck down with croup in the throat.'

On April 15, 1878, a sporadic case of diphtheria again made its appearance in Ilfracombe. It occurred in a very sheltered situation, some 90 feet above sea-level. Warned by the consequences of the preceding outbreak, early information was given to the local sanitary authority. From the very first day the sputa, the excreta, the linen, the throat were in various degrees all carefully disinfected. Some attempt was made to disinfect the air of the sick room. The attendants employed either hydrogen peroxide or potassium permanganate to their own hands and throats, and directly the child died she was enveloped in cotton wadding soaked in carbolic acid. The windows were kept closed, and ventilation was carried on by an open chimney and large fire. The infection extended only to the next row of houses, causing, in all, but three cases and two deaths.

I have now before me a diagram, which I prepared in 1874, showing the distribution of diphtheria in the Ilfracombe district during this epidemic of 1873 and 1874. It takes the form of a sketch map, and furnishes, among other particulars, the height above the sea line of the houses where this disease prevailed. Reference to it shows that out of thirty-two deaths, twenty-six occurred in houses on high levels. There is no exact record of the distribution of non-fatal cases, but in a report which was made at the close of the outbreak I find I used these words: 'The residences of nearly all the sufferers are on high levels;' and a medical friend remarked, 'I do not recollect having attended a true case of diphtheria below the level of the south side of the High Street of Ilfracombe.'

In the year 1873 Ilfracombe contained a population of 5,000 souls—some 3,000, in round numbers, living on the lower levels, and the remainder in elevated situations, corresponding to the ecclesiastical divisions of the parish. Yet, though the population then preponderated so much on the *lower* levels, and the houses were so much closer packed and by far the oldest, they were comparatively free from the epidemic which hung round *higher built* houses. Neither milk, water, nor drainage cast any light on the cause.

The author of the 'Dictionary of Hygiene' [1] speaks of the same epidemic as extending into the districts of which he then was the health officer, and observes, 'The fact of its preference for high, open, and airy situations was extremely marked, the places of selection being isolated houses on lofty hills. It was propagated also into houses where there were certainly no insanitary conditions whatever.'

Observations made during a single epidemic, however carefully recorded, are far too limited to prove that air is a carrier of the material of diphtheria poison, be its nature what it may. There may be better explanations of the phenomena I have described. The problem to be solved is this—Is diphtheria a disease generated *de novo* in healthy children, under certain circumstances, of which we are entirely ignorant, or is it only communicated by contagion and infection in the widest use of these terms?

And if this doctrine of communication be, as it most probably is, the true one, is air one of the communicating channels; and, if so, under what special circumstances?

Of the transporting power of air, we have the well-known illustration of sails of ships, 800 miles away from the African coast, being red with minute particles of sand, which lodge on them after a sandstorm on that continent. Some ingenious experiments of Dr. Blackley [2] may further explain the initial appearance of diphtheria on high levels, and its wider spread from such places. Blackley not only estimated the amount of pollen dust floating in the air, by exposing slips of glass moistened with a mixture of proof spirit water, glycerine, and carbolic acid, but he also determined the amount of

[1] *Dict. of Hygiène*, art. 'Diphtheria,' p. 186, 1st. ed.
[2] *Hay Fever, or Hay Asthma.* By C. H. Blackley. London. 1873.

pollen at different altitudes, by flying kites, to which prepared slips of glass were attached, and by these means has ascertained the interesting fact that there is more pollen in the upper than in the lower strata of air. In one experiment a breeze had been blowing for twelve hours from the sea, and a kite with a glass attached to it was elevated to the height of 1,000 feet, a similar glass being exposed at sea-level. After three hours' exposure, the kite glass showed eighty pollen grains, the one at the lower level not more than one or two.

The local condition of the atmosphere may have much to do with the vitality and perfection of diphtheria organisms, as well as their distribution, as in the case of the potato blight (*peronospora infestans*), whose ordinary aërial fructification depends for its perfection on fractional differences in the proportion of carbonic acid in the atmosphere, and the presence or absence of the sun's light-giving rays.

With three if not four forms of infectious fever are associated the presence in the tissues of abnormal forms of vegetation, which, first discovered by continental pathologists, are confirmed by the conscientious experiments of Dr. Sanderson. Professor Cohn has proved them to be spirilla, of the class algæ or sea-weed.

In the case of diphtheria, Dr. Oertel, of Munich, considers the primary disease to be local, and Letzerich is confident that it is caused by a fungus which attacks mucous surfaces from the outside. Dr. Von Naegeli classes these microscopic organisms or micrococci in a group which he connects with fungi.

Now algæ will be more closely connected with the aqueous propagation of diseases, but every botanist will place the fungi as aërial in their fructification.

Thus air would be the natural agent for the diffusion of these fungoid microzymes or cacozymes, as Dr. Alfred Carpenter proposes to name them.

Is primary diphtheria a local or a constitutional disease? A large portion of its history is an attempt to solve this vexed question. If the theory of aërial propagation by cacozymes be true, local symptoms would first show themselves. The rapid progress of the disease renders the separation of local from general symptoms difficult, but the history of the cases I have recorded certainly favours a local view of infection, both from the incidence of the disease and the early attention which was attracted to the throat; and again, if a careful daily examination is made of those who nurse diphtheria patients, in a great number of cases patches will be noticed on the tonsils and adjacent surfaces. In the event of adult attendants, these patches generally pass away without further mischief, without treatment, and without even the knowledge of the person concerned.

To practical sanitarians the methods by which diphtheria can be propagated are questions of the greatest interest; and should multiplied cases be recorded where isolation seems certain, and yet the disease spreads—and, on the other hand, where air poisoning is obviated and the disease is checked—we may fairly consider that the atmosphere carries diphtheria in a way somewhat similar to the water-spreading agency in typhoid.

It may chance to be near the truth that diphtheria is an air-spread disease, and that the mucous surface of the throat and parts that lie adjacent are proper for the initial growth and fruiting of its special fungus; just as in the case of enteric fever, the mucous surfaces of the intestines are proper for the life of the typhoid fungus, which is water-born and water-spread.

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A Century of Death-Rates at Teignmouth.

A FEW years ago I introduced into one of my annual reports to the Teignmouth Local Board a calculation I had made of the death-rate in that town for each year from 1795 onwards. The result of these calculations induces me to reproduce them, with observations, in the paper which I now have the honour to read to you. I have, since that time, calculated the death-rate backwards to 1780, and forwards to 1879, and have added besides calculations of the zymotic death-rate and of the enteric fever death-rate, as well as the birth-rate, for each year since 1838, when the registration of births and deaths commenced. This table I now present to you (pp. 67 and 68).

It gives in the first column the date of the year; next the population as ascertained every ten years at the census, then the corrected population for each year; afterwards as far down as 1842 the number of burials in the town during each year, as ascertained by me from the registers in the churches and chapels, and the burial-rate calculated therefrom; then from 1838 onwards the number of deaths in the town registered during each year, and the death-rate calculated from them; and in the next column the mean death-rate for each period of ten years preceding each year. Afterwards come the zymotic death-rate and enteric fever death-rate for each year, and finally the number of births registered in each year, and the resulting birth-rate.

In calculating approximately the population for the years preceding 1801, when the census was first taken, I have been thus guided. In a very valuable manuscript describing the then condition of Teignmouth and its previous history, written by Mr. Robert Jordan, in 1791, and to which his grandson, Mr. W. R. H. Jordan, of Teignmouth, has kindly given me access, that gentleman gives the number of houses then existing in the town as about 400. Taking the conventional rule of five inmates for a house, this would give a population of 2,000 for the town at that period. The actual census ten years after giving 2,012 as its population then, this calculation is probably not far wrong. Again in 1690, on the occasion of the burning of Teignmouth by the French, the number of houses in East and West Teignmouth is given as about 300 On the same ground of calcula-

Table of Death Rates, &c., at Teignmouth.

Year	Population at Census	Corrected population for year	No. of Burials	Burial-rate per 1000	No. of Deaths	Death-rate per 1000	Burial and Death-rate per Decenniad	Zymotic death-rate	Enteric fever death-rate	No. of Births	Birth-rate per 1000
1780		1945	38	19·5							
1781		1950	25	12·8							
1782		1955	22	11·2							
1783		1960	30	15·3							
1784		1965	34	17·3							
1785		1970	30	15·2							
1786		1975	33	16·7							
1787		1980	21	11·1							
1788		1985	28	14·1							
1789		1990	42	21·1			15·4				
1790		1995	29	14·6			14·9				
1791		2000	30	15 0			15·1				
1792		2000	39	19·5			16·0				
1793		2000	36	18·0			16·2				
1794		2000	25	12·5			15·8				
1795		2000	36	18 0			17·5				
1796		2005	30	14·9			15·9				
1797		2005	65	32·4			18·0				
1798		2005	22	10·9			17·7				
1799		2005	35	17·4			17·3				
1800		2005	38	18·9			17·7				
1801	2012	2012	36	17·8			18·0				
1802		2101	38	18·0			17·8				
1803		2190	37	16·8			17·7				
1804		2280	42	18·4			18·3				
1805		2369	35	14·7			18·0				
1806		2458	27	10·9			17·6				
1807		2547	51	20·0			16·4				
1808		2636	30	11·3			16·4				
1809		2715	36	13·2			16·0				
1810		2804	37	13·1			15·4				
1811	2893	2893	38	13·1			14·9				
1812		3001	54	17·9			14·9				
1813		3100	34	10·9			14·3				
1814		3217	31	9·6			13·4				
1815		3326	35	10·5			13·0				
1816		3435	50	14·5			13·4				
1817		3544	41	11·5			12·5				
1818		3654	60	16·4			13·0				
1819		3763	53	14·0			13·1				
1820		3872	49	12·6			13·1				
1821	3980	3980	61	15·3			13·3				
1822		4050	57	14·0			12·9				
1823		4120	70	16·9			13·5				
1824		4191	78	18·6			14·4				
1825		4262	74	17·3			15·1				
1826		4333	125	28·8			16·5				
1827		4404	76	17·2			17·1				
1828		4475	69	15·4			17·0				
1829		4546	105	23·0			17·9	8·8			
1830		4617	78	16·8			18·3				
1831	4688	4688	68	14·5			18·2				

Table of Death-Rates, &c. at Teignmouth—continued.

Year	Population at Census	Corrected population for year	No. of Burials	Burial-rate per 1000	No. of Deaths	Death-rate per 1000	Burial and Death-rate per Decenniad	Zymotic Death-rate	Enteric fever death-rate	No. of Births	Birth-rate per 1000
1832		4666	58	12·4			18·0				
1833		4643	110	23·6			18·7				
1834		4620	97	20·9			18·9				
1835		4597	79	17·9			19·0				
1836		4574	59	12·9			17·4				
1837		4551	75	16·4			17·3				
1838		4528	76		74	16·3	17·4	0·8	0·44	93	20·4
1839		4505	68		75	16·6	16·7	1·9	0·88	108	23·9
1840		4482	77		73	16·2	16·7	0·6	0·00	106	23·6
1841	4459	4459	64		67	15·0	16·7	0·8	0·67	105	23·5
1842		4528	69		67	14·6	16·9	2·3	0·22	119	26·2
1843		4597			63	13·7	16·0	1·5	0·00	108	23·4
1844		4666			101	21·6	16·0	2·7	0·64	124	26·5
1845		4735			88	18·5	16·1	1·2	1·05	146	30·6
1846		4804			82	17·0	16·5	1·6	1·04	145	30·1
1847		4873			93	19·2	16·8	2·0	0·82	130	26·6
1848		4942			91	18·4	17·0	4·6	0·40	140	28·3
1849		5011			155	30·0	18·4	14·1	1·59	165	32·9
1850		5080			76	14·9	18·2	1·3	0·98	166	32·6
1851	5149	5149			97	18·8	18·6	1·7	1·16	152	29·5
1852		5236			111	21·0	19·3	2·2	1·52	177	33·8
1853		5323			85	15·9	19·5	1·5	0·18	148	27·7
1854		5410			171	20·0	19·3	2·4	0·37	179	33·0
1855		5497			105	19·1	19·4	1·3	0·18	144	26·2
1856		5584			91	16·2	19·3	3·5	0·35	163	29·2
1857		5671			100	17·6	19·1	2·1	1·05	176	31·0
1858		5759			155	26·9	20·0	7·8	1·39	167	29·0
1859		5847			125	21·3	19·1	4·2	0·34	177	30·2
1860		5935			98	16·5	19·3	2·0	0·50	188	31·6
1861	6022	6022			113	18·7	19·3	2·4	0·16	161	26·7
1862		6094			123	20·1	19·2	1·4	0·16	171	28·0
1863		6167			106	17·1	19·3	1·6	0·81	186	30·1
1864		6240			114	18·2	19·1	2·5	0·16	154	24·3
1865		6313			128	20·2	19·2	3·0	0·47	160	25·3
1866		6386			115	18·0	19·4	3·3	0·94	156	24·4
1867		6459			121	18·7	19·5	1·8	0·15	160	24·7
1868		6533			105	16·0	18·4	0·7	0·61	142	21·7
1869		6605			125	18·9	18·2	2·5	0·60	171	25·8
1870		6678			142	21·2	18·7	4·0	0·30	176	26·3
1871	6751	6751			113	16·7	18·5	2·9	1·33	156	23·1
1872		6823			107	15·6	18·0	1·7	0·29	187	27·4
1873		6895			133	19·2	18·2	2·1	0·43	178	25·8
1874		6967			147	21·1	18·5	2·8	0·28	169	24·2
1875		7027			116	16·5	18·2	1·4	0·42	173	24·6
1876		7087			96	13·5	17·7	0·5	0·00	179	25·4
1877		7147			107	14·9	17·3	0·7	0·14	176	24·6
1878		7207			129	17·9	17·5	2·9	0·97	197	27·3
1879		7267			121	16·5	17·3	1·5	0·41	172	23·6

tion this would give its population at that time as about 1,500. From these data I have made the calculations which appear in the table, and which may, I think, be taken as sufficiently accurate for the purpose.

Teignmouth is situated at the mouth of the estuary of the Teign, here more than a third of a mile in width, on its northern side, mainly on the slope of the hills rising from the river, which at a distance of two miles attain an elevation of 800 feet, but partly on a shingly flat thrown up at the direct entrance of the estuary into the sea. This flat portion was not built on till after the beginning of the present century. Through it passed in those days the estuary of a brook, the Tame rivulet, which divides the parishes of East and West Teignmouth, while the Comb or Bitta Brook runs to the west of the town into the estuary.

The soil of the district is of pure red sandstone conglomerate with a subsoil of clay at varying depths.

The employments of the inhabitants are and have been pretty equally divided between those connected with seafaring and fishing occupations, those connected with agriculture, and those attaching usually to the various wants of a town.

Previously to the year 1836, the water supply of the inhabitants was entirely obtained from the two brooks above mentioned, and wells connected with various houses.

The public sewerage was scanty, and of the most imperfect kind, the estuarial portion of the Tame brook, contracted and gradually covered over, becoming the main sewer of the town. The latrinal accommodations of the several houses were, when present, of the outside privy and cesspit class, to which water-closets were being by degrees added. In no small number of the poorer class of houses arrangements of this sort were, however, altogether wanting, the excreta finding their way directly or indirectly into garden ground, refuse heaps, or the tideway of the river, while the adult males resorted usually to the sea-shore, the fields, or lanes.

In 1836 an Act of Parliament was obtained, under which powers were conferred on a Board of Commissioners for constructing a reservoir, supplying the town with water (the water of good character being conveyed from the hill above the town), for providing public sewerage, for widening streets, for the watching and lighting of the town with gas, and for its general improvement. In 1859 the town placed itself under the Local Government Act, and a Local Board took the place of the Improvement Commissioners. Under these bodies the work of sanitary improvement has been carried out from those dates to the present time. A supply of good water has been provided, and has been carried throughout the town, and private wells have gradually been, with few exceptions, disused or stopped up. Streets have been widened, and new houses built in accordance with by-laws sanctioned by the Home Office. Drains have been laid in streets where before they were absent, and the Tame brook and other main sewers have been covered over and carried down to low water mark, the amount of 5,680*l.* having been expended by the town between 1850 and the present time, in works of sewerage alone. But what I wish to draw attention to in this paper is this, that with all these steps taken in the direction of sanitary progress, the death-rate was considerably and persistently higher after these works had been engaged in than it had been before, a fact rendered more palpable in the column of death-rates for decennial periods. Thus the rates, which ranged between 12 and 14 per 1,000 in the decenniads ending with the years from 1813 to 1823, and from 16 to 17 in those ending between 1839 and 1848, ranged between 19 and 20 in those ending with the years from 1852 to 1867. From this date the rates have again decreased, and at present, it will be seen, they have declined to 17·3 per 1,000.

To what are these facts owing?

That sanitary improvements in a country or a town result, speaking generally, in diminished death-rates, is not a point at present open either to questioning or discussion. The proofs of it are ample and irresistible. It may be worth while, therefore, to inquire as to the probable causes of what at first sight seems so anomalous.

It may be said that a burial-rate cannot be compared with an actual death-rate. This to a certain extent is no doubt true, and requires to be allowed for; but as railway communication with Teignmouth did not exist before 1846, and as the means of transport in use before this were attended with a good deal of trouble and expense, it is possible that at the period when the burial-rates were the lowest they pretty nearly represented death-rates also. It will be observed, too, as to the four years from 1838 to 1841, in which both the number of deaths and that of burials are given, that these did not widely differ from each other, and also that the burial-rates before the early part of this present century were decidedly higher than in subsequent years, and more nearly resembled the death-rates that afterwards obtained.

I would look, therefore, for the explanation to another cause.

Teignmouth, during the last century, existed as a small sea-side fishing town and port, but at the close of the century, the time when Mr. Jordan wrote, it began to come into notice as a resort for visitors, and during the first thirty years of the present century it had become a watering-place of fashionable repute. This prosperity, the rise and development of Torquay, and the setting of the tide of fashion in that direction, materially diminished, and it will be seen that the population of Teignmouth, which had risen rapidly from 2,012 in 1801 to 4,688 in 1831, had declined in 1841 to 4,459. At the same time the population of Torre and Torquay, which in 1801 was only 838, in 1831 had risen to 3,582, was 5,982 in 1841, and in 1851 had reached 11,465. In 1846 the South Devon Railway was opened to Teignmouth, and its population began again to increase. In 1851 it stood at 5,149, in 1871 at 6,751, and is probably now about 7,250. We have here, then, within the last eighty years, two periods of increasing population in the town, the one attended by a low death-rate, the other by a higher one. What has made the difference? I believe this—that in the first of these two periods the increase in population was in that of the wealthier classes, both amongst visitors and residents, while owing to this, and to the Newfoundland trade then flourishing, there was a general absence of real poverty amongst the lower classes as well; whilst in the latter of these two periods the increase was—at first at least (and it ultimately became a permanent one)—in the poorer and the labouring classes of the community, and those less stationary in their habits and possessing on the whole less of the conditions of physical comfort than their fellows of former days. It is to this preponderance of the poorer classes that I would ascribe the higher death-rates in the latter than in the former of these two periods. The last ten years have seen an increase again in the wealthier classes, amongst residents as well as visitors; but as the visitors increase the population principally during the summer and autumn months, while the census is taken in April, the death-rate of Teignmouth has always an extreme value, and is unmodified by the effect which the presence of the migratory part of its population at an opposite time of the year would produce.

If, then, the explanation I have proposed of the marked difference in the death-rate at these two periods of the town's history, and of their increase after sanitary works had been progressing, be correct, what are the causes of this preponderating death-rate in a poor as compared with a wealthier population? They are not, I fear, far to seek, and are too well known to all of us.

Briefly they may be described as greater exposure to cold and damp, to rapid changes of temperature, and to other hurtful meteorological influences; to greater liability to suffer from dangerous and unhealthy occupations; to insufficient clothing; to insufficient or unwholesome food; to neglect of cleanliness; to the presence of a more vitiated atmosphere in and around their dwellings; to greater ignorance of the laws of health; and to greater carelessness in the use of means to ward off or to get rid of disease.

This dependence of an increased number of deaths in a population upon the conditions above recorded is, I think, not unaptly illustrated by the record before you; but other lessons also are, it appears to me, to be learnt from it. The causes of mortality just mentioned may doubtless all be classed in a broad way under the head of insanitary conditions, at least of conditions inimical to health; yet many of them, it will be seen, are conditions of the people in their private and individual circumstances and habits, not of the locality in regard to its public economy. I would therefore submit that in studying death-rates for investigating the sanitary condition of a town or district at any particular time in comparison with that at another time, and much more in comparing by their aid the sanitary condition of one town with another, the relative proportions of the poorer and wealthier classes, and the nature of the occupations of the inhabitants, are material elements in the inquiry. I fear that not unfrequently a comparison between the death-rates alone of one town and another at a given time, or between those at two different periods of time in the same town, is too hastily taken as in itself an absolute indication of the relative sanitary characters of the places or times, and of the progress and energy of their respective sanitary authorities. Unless with limitations, and guided by further investigation, an injustice may thus be haply done. No action of a sanitary authority can influence climate or weather, can provide food, fuel, or clothing, can supply forethought or prudence, or can affect the social habits or the occupations of a population; and for these they cannot be held responsible. There is that, however, which is always in their power—fully and faithfully to perform their own functions, thereby to blunt the power of evil in that which they cannot immediately affect; and in these very matters to recognize the direction in which further progress is to be sought for, and by their influence to direct public feeling and mould the habits of the community. There is another point, I think, worthy of attention. It will be seen that sanitary conditions being the same, yet the death-rate differs, sometimes widely, from year to year, and from causes, doubtless, which cannot be classed under that head. It is not well, therefore, to look for a diminished death-rate as a necessarily immediate consequence of sanitary improvements in a locality, nor is it wise to press upon the public any smaller death-rate which may happen to occur soon after, as evidence of these good results. The student of sanitary science is not called on, so to speak, to hold a brief even for truth. Rather he should in a judicial spirit weigh the evidence obtainable from all sides, and form his opinion carefully thereon. Sooner or later sanitary work will necessarily tell, and for its results we may afford to wait.

I have spoken of the increase of the wealthier classes in Teignmouth during the last ten years. During the same time the death-rate has been materially decreasing. Is this decrease referrible to that as its cause? is it the result of continuous sanitary labours? or are both of these circumstances factors in its production? Neither ought probably to be excluded. Yet it is not to this decrease in the general death-rate I would look particularly for evidence of the result of sanitary action. I would rather point to the diminished death-rate from enteric fever. The mean of this from 1865 to 1869 was 0·55 per 1,000; from 1870 to 1874 was 0·52 per 1,000; from 1875 to 1879 was 0·39 per 1,000. Much has been done in the town during this time. More strictly each year are nuisances and sanitary defects searched for and remedied, and requirements for health insisted on in new houses; while the public sewerage is in a process of entire remodelling, and means are being taken to increase the amount of its water supply, which in quality leaves little to be desired. By continuance in this course we may well look forward to increasing evidence of what earnestness and perseverance can effect in the conflict with disease and death.

I will now turn to the zymotic death-rate, and strictly sketch what I know of the occurrence of this class of diseases, excluding enteric fever, in Teignmouth. It will be seen that a high death-rate for a year very frequently includes a high zymotic death-rate also, but this is not always the case; in some years it is much the reverse. A *very* high death-rate, though, would appear to indicate a high zymotic death-rate as well, as in the years 1849 and 1858. We may therefore presume that the burial-rate for 1797 of 32·4 per 1,000, the highest death-rate in the whole table, was mainly caused by fatal epidemic disease. Owing to the unusual occurrence of the causes of death having been entered for two or three years in the registers of burials of East and West Teignmouth, I find that 40 of the 105 deaths occurring in 1829 were from small-pox, or at the rate of 8·8 per 1,000. 1833 was the date of a severe epidemic of influenza. In 1842 and 1843, of the 18 deaths from zymotic diseases, 12 occurred from small-pox; in 1844 there were several deaths from whooping-cough; in 1848 there was a large mortality from measles; and in 1849, which year has the highest zymotic mortality since the registration of deaths began, both small-pox and scarlet fever were excessively fatal. In 1852 small-pox and measles again visited the town, and whooping-cough in 1853. In 1854, 1855, and 1856 scarlet fever again occurred, but mildly, accompanied in the latter year by measles and by a severe epidemic of whooping-cough. In 1857 diphtheria appeared for the first time, at least as so recognised. In 1858 scarlet fever showed itself in the autumn without at first exhibiting any peculiar character; but in connection apparently with the setting in of a strong cold wind from the east, it assumed a character of great fatality, almost confined to the lower classes, and in conjunction with measles produced a zymotic death-rate the next highest to that of 1849. In 1859 scarlet fever continued this loss severely, and whooping-cough appeared with much severity. In 1860 a few cases of diphtheria and of small-pox again occurred, and in 1861 a few of small-pox and subsequently of whooping-cough. During the next three years occasional cases of the latter complaint and of scarlet fever showed themselves, and in 1865 scarlet fever again occurred in considerable force. In 1866 small-pox again appeared, though neither extensively nor severely, and in the autumn of the year Asiatic cholera, from which disease 8 deaths occurred. Measles occurred epidemically again in 1867 and 1868, and scarlet fever very extensively but very mildly in 1869, and to a small extent, but more fatally, in 1870, accompanied in the latter year by whooping-cough and measles. In 1871 small-pox appeared for the last time to the present date in Teignmouth. A solitary case brought into the town was isolated, but through the nurse's disobedience her daughter was attacked by it, and by her it was communicated to her father. This man, pitted by former small-pox, died. This occurrence sent the whole neighbourhood in a fright to the vaccinator, and the disease was thus stamped out. Whooping-cough prevailed particularly in 1873, 1874, and 1878; measles in 1874, 1876, and 1878. Since 1870 cases more or less isolated of scarlet fever have from time to time occurred, but there has been only one death from it in the last eight years, that being of an introduced case.

In calculating the zymotic death-rate, I have followed the usual course, but I do not scruple to express my opinion that the grouping together, under the head of zymotic death-rate, of the death-rates from the seven or eight maladies to which the title 'principal zymotic diseases' has been given is misleading, and in the present state of our knowledge injurious to progress. In public opinion, supported ever by medical authority, deaths from these particular diseases are regarded as peculiarly preventable, and preventable by the direct action of sanitary authorities. With neither of these views can I entirely accord. There are other diseases where mortality is equally preventable by sanitary measures, and the diseases thus grouped together differ much from one another in character, and are very variously amenable to preventive means. Small-pox and enteric fever most probably are strictly preventable, though in different ways. Diphtheria may possibly be so, but scarlet fever, measles, and whooping-cough are only indirectly so. Over the mortality of the two last meteorological influences have, as a rule, far greater power than those usually called sanitary; while over that of scarlet fever, though both these influences have power, yet in some epidemics of this disease it is difficult to say to what either its mildness or its severity is to be ascribed. For preventing the spread of each of these when developed, isolation (a provision for which ought to exist in every town), if effectually carried out, is a certain means; but with scarlet fever, measles, and whooping-cough, this is the only means of prevention. Enteric fever and small-pox stand in a different, but a separately different, category. It may not be too much to say that enteric fever is a disease whose extinction may be compassed by sanitary means, but can it rightfully be said that vaccination prevents small-pox? Do we not rather deliberately communicate it in a highly modified and a lessened form, in order that it may be passed through safely and at once?

Why, again, should diarrhœa be placed, and separately, in this zymotic group? If measles and small-pox, if whooping-cough and enteric fever, occur in a patient at the same time, we recognise the presence together of two distinct diseases; but do we thus when diarrhœa occurs in their course? Diarrhœa, speaking broadly, is intestinal catarrh, and may result from widely different causes, and be the index of very different states. Diarrhœa may be a form of enteric fever, or of cholera; it may result from poisoning by sewer gases or other similar forms of pollution; it may be a substantive and true zymotic disease, the result of unhealthy sanitary conditions; but it may also arise from unwholesome and improper food, and to a very large extent indeed it yearly owes its origin to meteorological causes, occurring in a period of falling temperatures, and increasing moisture following a hot day or hot and dry weather, and may be regarded as the correlation of the naso-bronchial catarrh which occurs during a thaw after a period of cold and dryness. Why should a malady so various in its character and causation be classed with diseases so distinct as measles and scarlet fever? and why should the mortality from all these be grouped together, when they differ so widely amongst themselves in their relation to sanitary work and measures? Why should not the mortality from each stand by itself, and be considered with reference to its own causes and relationships?

I trust from what I have said now, and in a former part of this paper, that I shall not be thought to undervalue the importance of high death-rates generally as a warning of the presence of sanitary defects or of unhealthful conditions, or that of those from zymotic diseases or from diarrhœa as a part of them. Their importance cannot be over estimated, but to learn rightly from them they must be studied thoughtfully and critically in all their bearings, and I would deprecate anything that would tend to vagueness and a delusive generality in the place of clearness and precision. There is much also in the character and progress of disease, and its relation to the conditions we live in, of which we are still ignorant, but this does not excuse us from the responsibility of action in that of which we are not ignorant. There have been pestilences of the zymotic class in England, which we now know of only by name, and unable as we may be at present to act directly and consciously on the essential causes of many diseases of this class, yet each year brings these, as other diseases, more within the grasp of sanitary control. By ensuring to the community pure air, pure water, protection from other hurtful influences, wholesome surroundings, and the means of healthful development, we can not only remove the very causes of much of disease, and increase vital power and the capability of resisting it, but we may by these same measures succeed ultimately in blighting the seeds of the zymotic diseases themselves, and in destroying the means of their development. The result of our endeavours will ever belong to God—it is for us in the prosecution of means to follow the precept of the preacher of old—'Whatsoever thy hand findeth to do, do it with thy might.'

W. C. LAKE, M.D.

Mr. CHADWICK said he should like to know if Dr. Lake had any definite opinion as to how the heavy death-rate in his district might be reduced?

Dr. LAKE replied that he had great faith that improvements in sanitary measures would reduce it.

Dr. RICHARDSON said he agreed with Dr. Lake that the question why, with sanitary improvements, the death-rate did not fall, was a very important one. He rather inclined to the explanation Dr. Lake put to it, viz., the great increase of population in advance of the sanitary improvements. He should like to know if the increase of population had been in excess of the improvements. Teignmouth had great advantage in the way of means of sanitation, and they ought to see a great diminution in the death-rate.

Dr. LEWIS SHAPTER thought that sanitarians were laying a little too much stress on the death-rate, and overlooked the prevalence of diseases which were not fatal. In the death-rate they were dealing with disease which was fatal, but they did not deal with that larger class of disease which was preventable and not necessarily fatal. No doubt there was in a town of that class a number of preventable diseases, which did not in any way come in the death-rate, and they could not trace the measure of progress by it. Mr. Chadwick had placed in his hands a new form of death-rate, showing the proportion of deaths from zymotic diseases. He thought that would elucidate a very important point, for at present they could not tell how many deaths out of 100 were caused by scarlet fever and so on. He wished to call attention to this mass of preventable diseases, which Dr. Richardson had hinted might be traced to defective sewerage. One point to which he wished to direct attention was that these diseases came round in the spring and autumn, either in the form of mumps, or measles, or low fever, occurring when the alteration in the temperature would make an impression on the sewerage. Referring to a list of patients at the Exeter Dispensary, which treated this class of diseases, he saw that out of 5,000 cases 1,278 were suffering from a kind of low fever, and the diseases of children. In addition, no less than 7,476 persons were relieved for diarrhœa, vomiting, and colic. The Dispensary did not deal with the very poorest classes, and yet there were as many as 8,000 treated for this class of diseases in the small area covered by the Dispensary. It seemed to him, therefore, that they should not lay too much stress on the death-rate as on the class of diseases that arose, and more especially those attributable to insanitary conditions. He referred to the choleraic period, as showing that it was true economy to keep our houses in order. It was a question of not letting zymotic diseases take hold of them; if they did, they had the expense of stamping them out, which was far greater than preventing them in the first instance. All this shadowed forth the truth that something more was to be considered than the death-rate in considering the sanitary condition of a city.

Dr. Taylor (of Norwich) remarked that he had spent nine years in the City of Berlin in a quarter where both air and water were tainted with sewer air, and he had not himself suffered in any way.

Mr. Karkeek (Medical Officer of Health, Torquay) called attention to the fact that typhoid fever amongst the poor was very rare in that place. He attributed this to the fact that in the cottages all sanitary appliances were out of doors.

Mr. Rawlinson, in pointed reference to what had been said by Dr. Taylor, remarked that he had probably made as many inspections as any man in the room, and had often come across the "look-at-me" man, as if, because one person suffered no ill from evils, that therefore they were innocent. He had no patience with a man of a cast-iron constitution setting himself up as an example. It was strange that, though, as they knew, dirt created disease, yet that the men employed on sewerage works did not in some instances appear to suffer from disease. But it was a fact that many of the men employed in the sewers could not stand the seasoning. He himself had passed through the hospital on the Bosphorus, where 4,000 or 5,000 of our soldiers were lying, down with putrid fever, and did not contract it; but in inspecting Uppingham School he caught it, and it was only by great care he got over the attack. A good deal had been said about the unwholesomeness of private dwellings; and they knew the poor would close every hole, as they preferred warmth to pure air. He believed that was owing to their not being properly clothed. For his own part, it was always necessary to keep his window open at night as well as by day, but then he was dressed to meet this. He believed that he was right in saying that consumption, which was formerly coddled, and the patient kept in close rooms, was now proved to require plenty of cool air. He believed that if people could bring themselves to live in a temperature a little higher only than that outside they would be a great deal better in health.

After a few observations from Professor Symons, Dr. Lake, and the President of the Section, the discussion ceased.

The Unhealthiness of Public Institutions.

In a paper read at the Sanitary Congress at Croydon last year,[1] I drew attention to the sanitary defects which had been found to exist in some of the older public institutions in this country. Special reference was made to the Manchester Royal Infirmary, which had been reported by Mr. Netten Radcliffe, of the Local Government Board, to be unhealthy from cellar to garret. The defective health arrangements at the large lunatic asylums were referred to, and the condition of the County Asylum, at Frome, where 32 cases of spontaneous erysipelas occurred amongst the inmates, between December 1878 and May 1879, was selected as a typical example of the insanitary condition of the majority of such buildings. At neither Manchester nor Frome could reliable information as to the drainage arrangements of the buildings be obtained, and no proper plans could be found. It was further stated that investigation had brought to light the startling fact, that not 10, and possibly not 5 per cent. of all the hospitals throughout Great Britain and Ireland, possess any reliable plan of their drainage arrangements. Even some of the most important hospitals in the kingdom had no such plans, and it would be easy to give instance after instance of the culpable ignorance which prevailed on this important subject. Remembering the foregoing facts, I ventured to ask, what is the probable condition of the drains of all institutions built some 50 years ago? I much regretted at the time that, through an accident, no discussion was possible last year when I read my former paper. I hope, however, that there will be a full discussion to-day, and that good will result.

It will be noticed that last year I specially referred to old institutions as opposed to recent buildings. I took it for granted, that buildings erected within the last ten years would certainly not suffer either from insanitary construction or defective drainage. From the amount of attention which questions of hygiene have excited, and the numerous and competent authorities who have written and spoken on the subject in all its branches, it might at first sight have been taken for granted, that architects of more or less eminence would have brought much intelligent study to the consideration of the right construction of drains and of sanitary arrangements generally. Unfortunately experience proves the reverse to be the case, and if anything, the newer the building the worse is probably its sanitary condition. Is it not time that the Royal Institute of British Architects took up this question of sanitary construction, and that its Council should make regulations for the guidance, instruction, and training of the rising generation of architects? Such a course will ultimately guarantee the public against the defective, unhealthy, and discreditable condition of many public and private buildings which have been erected under the supervision and from the plans of some of the most eminent men in the profession. It is quite certain that the Institute of British Architects must declare, either that the profession repudiate all responsibility for sanitary defects in dwelling

[1] See page 95 of Vol. I. of the 'Transactions.'

houses and large public institutions, because hygienic arrangements are no part of an architect's business, or they must promptly offer adequate guarantees to the public which will protect it from the disastrous results which now, alas, too frequently follow the occupation of a newly-erected edifice. Suppose a wealthy client pays a large sum for the erection of a new house, which he has been assured by his architect is planned and arranged upon the most perfect system known to modern science. The architect cannot expect that such a client, however much he may be reconciled to the anxieties and increasing expense of each addition to his family, will, without remonstrance, submit to an annual and increasing outlay for sanitary alterations and drainage improvements, rendered necessary by the carelessness or ignorance of the architect himself. It may be thought that new buildings are as a rule carefully erected, and that there is no justification for the foregoing remarks. Unfortunately for architect and client, such is not the case.

Since the meeting at Croydon the following cases have come under my notice, and I hold myself responsible for the accuracy of the following descriptions of three new buildings, *a hospital, a convalescent institution, and a lunatic asylum*, which have all been built, opened, and occupied within the last seven years. All names are purposely withheld.

The Hospital had not been in occupation for more than 18 months when the atmosphere of the building and the ill-health of the inmates pointed to defective drainage and construction. An examination of all the drains, baths, and other conveniences, proved the sanitary condition of the building to be most unsatisfactory. It soon became evident that very considerable alterations were needed to remedy the defects. This new hospital had therefore to be closed within three years of the date on which it was opened. A thorough investigation brought to light the following facts: The cisterns were placed so high that the pressure from the main was seldom or never sufficient to fill them. In consequence there was a gradual choking of the drains throughout the hospital, and an admission of sewer gas to all parts of the building. No man-holes or means of inspection were provided, and the plans of the drains were found to be unreliable. With four exceptions the drains were laid outside the building, but the levels were very irregular. Thus: the level at the lower end of a drain was 1 in 60, higher up it was 1 in 24, and above this again 1 in 125. No wonder that the drains were found to be choked. The pipes also were badly laid. In some places they were leaky, and very foul excrementitious matter was discovered in the soil near them. All pipes were pointed with clay, not embedded in cement, and few were water-tight. In fact, the defects were serious enough to guarantee the admission of sewer gas to all parts of the building. The hospital drains were in direct communication with the town sewer. The rain-water pipes opened directly into the drains, they were untrapped, and as they were only carried to a level with the upper part of the windows of the top wards, they conducted volumes of gas from the sewer to the wards. The soil pipes were all inside the building, and were trapped at the foot, and ventilated by smaller pipes carried up a certain height and then bent over. These traps were quite inaccessible, and the soil pipes were not properly ventilated, as they were only open at the top, so that no current of air could pass through them. As there was no inlet at the ground level, foul air was forced out through the lower closets into the hospital, whenever any considerable volume of water passed into the soil pipe from the upper floors. The slop-sinks discharged into the soil pipes, and were practically untrapped, so that by their means sewer gas was laid on to every ward in the hospital. There were other defects, but I have given enough detail, and no one will be surprised that the sufferings of the surgical patients and the general unhealthiness soon compelled the committee to close the hospital.

The Convalescent Institution stands in its own grounds of 8 acres. It is beautifully situated. It has extensive gardens, and every convenience, not to say luxury, that modern taste could suggest. The cost of the site, buildings, &c., was upwards of 50,000*l.*, there is accommodation for some 200 patients, and it has been occupied for less than five years. Within a year of its being opened there was a sharp outbreak of erysipelas amongst the patients, and the institution was closed and fumigated. It was noticed at the time that all the conveniences opened into the building directly opposite the wards, and a suspicion of defective drainage arose, but was not credited, owing to the fact that the building had been occupied for barely one year. A few months ago the unhealthiness of the institution was so marked, that the committee gave instructions for a complete examination of the drainage system. No plan of the drainage could be found, but one was ultimately furnished by the architect which proved to be incorrect in many particulars. All drain pipes, &c., were found to be in and beneath the building. The baths, lavatories, and sinks opened directly into the sewer, and many were untrapped. In that portion of the building allotted to the officers, owing to an ingenious arrangement of the lavatories and the pipes connected with them, sewer gas was admitted at both ends of each floor. The ventilation of the drains and sewers was so defective, that during certain winds the sewer gas was driven through and into the building by means of the ventilators. Some of the drains were laid up-hill, all were pointed with clay and not embedded in cement, and all leaked. The main sewer as it passed from the building was laid at irregular levels, and in more than one place, owing to imperfect workmanship and improperly made ground, the pipes of which it was composed were not in contact with one another. The main sewer had to be entirely relaid. All the drains were taken up, and with the soil pipes were placed outside the building. It is not to be wondered at, in the face of the foregoing facts, that instead of being a convalescent institution, these defects of construction compelled the convalescents to return, not to their own homes, but to the hospitals from which they came; whilst the majority of the resident staff were placed on the sick list. Yet the architect had in this case unlimited funds at his disposal, and the fullest liberty to do all that he thought necessary or desirable.

The County Lunatic Asylum has been opened for the reception of patients for five years. Built regardless of expense, it was supposed to contain all the most recent improvements in lunatic hospital construction. Almost from the date of its occupation it has been the scene of outbreaks of dysentery and erysipelas. During the first eight months of 1879, cases of these diseases were of constant occurrence on both sides of the asylum. There were twelve fresh cases of dysentery and four of erysipelas every month.[1] Suspicion having fallen on the state of the drains, a competent engineer was ultimately appointed to examine them. Numerous faulty points in the system were detected, the rectification of which has been followed by the disappearance of dysentery and erysipelas from the establishment.

I have here given positive proof from the experience of the past twelve months alone, that the architects who have been entrusted with the erection of these large public buildings devoted to medical purposes, have shown an ignorance, or, if you prefer it, a total disregard, of the elementary principles of sanitary science. I content myself with stating these facts. I refrain from comment, but I appeal to the Royal Institute of British Architects to apply a remedy which will prevent like abuses for the future. If they fail to do this, then let them boldly hand over all matters affecting drainage and sanitary construction to the engineer. By this means they can readily avoid a heavy responsibility, and save their profession from much discredit. I must, however, leave the decision to the professions more immediately concerned, and I hope the discussion which may follow this paper will lead to a satisfactory settlement.

It behoves the public to take the question up from a different point of view entirely. Private houses and public institutions are not free, as they ought to be free, from preventable impurities, and they are too often highly dangerous abodes for anyone who has a tendency to zymotic disease. No permanent prevention is likely to be secured without a thorough, an independent, and a periodical inspection of all the structural and drainage arrangements of these buildings. A central office for the safe custody and registration of the drainage and other plans of all public buildings, hospitals, and private houses is a much needed reform. Competent inspectors and a central repository might be secured for a reasonable outlay, which would be over and over again repaid to those who were sensible enough to avail themselves of its facilities. At the present time no one seems to think of drainage arrangements. Nearly everyone is contented with a taking exterior. Yet the magnificent elevation of the block of new buildings known as the new Government Offices did not protect its inmates from the inconvenience and danger attending the presence of several inches of liquid sewage, which was found in the basement of the Home Office within a few weeks of its occupation. Could the Congress better employ its time, than in appointing an influential deputation to the Local Government Board, to recommend strongly the adoption of the necessary remedies for the removal of the evils which have been brought out by the facts detailed in this paper?

HENRY C. BURDETT.

[1] Brit. Med. Journal, September 4, 1880; page 401.

DISCUSSION.

Mr. Ernest Turner (London) said Mr. Burdett's paper was a very interesting one, and had two sides—a comical side and a serious side. It was certainly rather comical to hear Mr. Burdett blaming the architects for not taking care to exclude sewer gas from buildings, which owed its existence in the sewers to faulty engineering, and then to hear him shortly afterwards suggesting that the architects should boldly hand over all matters affecting drainage and sanitary construction to the very people who caused the evil, or who at any rate constructed the sewers in which sewer gas accumulated. Lord Fortescue had referred on the previous night to noticeable defects in lately-constructed sewers. But who had constructed them? The answer was, sanitary engineers, and not architects. The truth was, there were engineers and engineers, and architects and architects, and the functions of the two were distinct. The engineer should know how to dispose of sewage, and the architect should know how to drain the buildings he erected. But both professions had yet much to learn, and he did not believe that either of them was at a standstill. Anyone who had read the *Builder* would know that the editor of that paper was a pioneer in sanitary reform, and that to him attached the honour of being the first to call public attention to the fever dens in different parts of the country, and give prominence to sanitary construction in all its branches. The Society of British Architects had for years been trying to get the Legislature to make examinations compulsory, but in this they had failed. But no one could be admitted to that Institute until he had passed an examination in which sanitary construction and drainage were included. What the engineers had done he did not know, but he did know that there were many able men amongst them, and on the other hand there were some totally incompetent, holding responsible positions, and having charge of the sewers of large districts. He was lately asked to inspect a house where the occupier was told the drains were perfect. On examination he found that all the drains were below the level of the sewer, and this was also the case in several of the adjoining houses. That was a serious matter, and what, he asked, was the use of Boards of Health and Vestries making regulations and not having responsible officers to see that the regulations were complied with? Before new buildings were erected plans should be submitted, and the drains should be inspected after they were laid. As to the burning question of excluding sewer air from buildings, there was nothing more simple, though from the hundreds of patent advertisements they were led to believe that it was difficult. Between the house and the sewer there must be a simple syphon trap, and a portion of the drain between this trap and the house must be open to the air. All the soil pipes should be carried above the roof and open at the top. They would then have a current of fresh air always passing through the drain and soil-pipe. Disconnect from any drain or soil-pipe every waste pipe in the house, and let every waste pipe discharge on to, not into, a water-trap. The noxious gases in the sewer still remained to be dealt with but that was the work of the engineer, and he should be required to do it. Mr. Turner moved a vote of thanks to Mr. Burdett.

Dr. Domenichetti, Medical Officer of Health (Louth), in seconding the motion, said the art of sanitation appeared very simple from the address of Mr. Burdett. As to the army of inspectors suggested, he would only say that he considered that in the present body of health inspectors they possessed a very valuable body of men. At least that was his experience in Lincolnshire, where he resided, and he believed that large towns could be properly administered if a proper staff of officers were provided. He gave instances which had come under his notice in which this was done.

Mr. W. White (London) desired to express his thanks to Mr. Burdett for the valuable paper he had given them, and also to Mr. Turner for the defence he had made as to where the responsibility rested. The speaker pointed out that it was only within the last few years that the science of the management of sewer gas had been worked out by the great intellects of the day in the medical, engineering, chemical, mechanical, and other scientific branches. Therefore it was rather hard to say that the architect who provided the building was to initiate all these scientific investigations which had occupied most scientific men of the time for many years past. He, however, believed that the architects had been doing their best to remedy the defects that existed.

Dr. Alfred Carpenter said he could not allow the paper to pass without remark. It dealt with two matters—principles and details, and he thought principles rather than details should be dealt with by the Congress. They owed a debt to the people of the city for the reception given them, and they could not pay it better than by dealing with this matter. It was quite certain that people did not know the right way to execute these works, and therefore engaged persons to carry them out who they supposed were properly qualified for the purpose. But, as they knew, a large number of the officers appointed by the local boards and others were totally ignorant of what was required. He had seen work carried out by men well known in the country who were totally ignorant of sanitary hygiene and of the first principles of sanitary construction. Consequently, the works they had managed had failed. When men were appointed inspectors of nuisances in large towns, it should be seen that they knew something of the duties they undertook. But inspectors of nuisances, as a general rule, knew nothing of their duties, and, indeed, he believed that nine-tenths of the surveyors and inspectors were not acquainted with the first principles of sanitary laws. Those who had paid attention to these questions knew that some sewers were apparently made for the purpose of creating sewer gas. Sewer gas was no part of the sewer system, and any engineer who made a sewer which created gas made it improperly, and wasted the money of people who trusted him. One of the objects of the Institute was to endeavour to get officers appointed who knew their duties in this respect. As to the appointment of medical officers of health, he would warn them against appointing men on the understanding that they were not to do their work. If they appointed a medical officer for a large district at a salary of 25*l.* a year, they would know that he was appointed with the understanding that he was not to do his duty.

Mr. E. J. Domville observed that they had somewhat wandered from the subject, which was the unhealthiness of public institutions rather than that of private houses. As an old officer of a public institution, he should like to bear testimony to the rather remarkable difference between the recurrence of such diseases as were usually engendered in hospitals—in the Exeter Hospital and the hospitals in London. Coming straight from one of the London hospitals, he was much struck by the freedom of the Exeter hospital from pyæmia and erysipelas. The question was, what was the reason for the difference? It seemed to him that, to a large extent, the overcrowded state of public institutions was the cause of this disease. But in the Exeter hospital he noticed one point which was remarkable, and which, as far as he knew, did not exist in any other hospital, viz., the custom of spreading the cases of the surgeons all over the hospital, and spreading them amongst those who ought not to be there at all, persons suffering from chronic diseases, and so on; and this, perhaps, might have had something to do with the very few cases of the particular diseases he had mentioned. As to the question of sewerage, it seemed to him that it was not only a question for the architect, but that they must go far lower, and impress upon the workmen the necessity of carrying out the orders they received; for at present they seemed to think that an inch or two of difference in the sockets, or the use of clay instead of cement foot-joints, made no difference. He did not think that the working classes were aware of the responsibility that rested with them for the evils arising to the health of families by bad work of this character. Supervision was also necessary, and no sewer or drain should be closed until it was inspected. By this means they would get a plan of the drainage, which was as necessary as that of the elevation.

Mr. Square (Plymouth) thought that between the architects and engineers the public had a right to look for security.

Mr. J. Towle (Oxford) observed that it had been said by Dr. Carpenter that there ought to be no sewer gas in their sewers, and he went further and said there ought to be no pernicious gas in their towns. The question was raised at Glasgow whether it was possible to remove the pernicious gases from our towns in twenty-four hours. He had worked this matter out, and had come to the conclusion that they could carry everything out in twenty-four hours, so as to prevent sewer gas arising.

Dr. Richardson said that up to the middle of last century hospitals were in a bad condition, but in 1762 there was a great revival in the building of hospitals under the direction of Mr. Gooch, of Norwich, who built upon a plan laid down by an intelligent architect. Some of these hospitals were exceedingly well constructed, but he would point out that in the end the concentration of so many patients and the saturation of the place itself proved injurious to them. The point to be gathered was that they should never build hospitals as if they were Norman castles. They should be built in some simple way, so that they might be removed and reconstructed. At any rate, a hospital should be so built that it could be partitioned into wards that could be taken to pieces, and reconstructed at pleasure—so arranged that they could be taken away piece-meal and repurified. In that case they might have hospitals that might be permanent. But in all cases care should be taken not to build large hospitals. To concentrate the sick in a large hospital like that of St. Thomas's (Lambeth) was not desirable, and that hospital should be spread all over London. As to the removal of the sewage of hospitals, he was not sure that the earth system was not the best for sewage, but with regard to all other matters, such as dressings, they should be destroyed by fire. The walls of hospitals, too, should be lined with sheet-iron, so that a brush of fire could be passed over the walls and destroy all organisms.

Mr. H. C. Stephens suggested that the Institute ought to be able to insist upon there being a means of testing the capabilities of inspectors, through the Local Government Board, who had to confirm the appointment to ensure half of the salary being returned to the Local Board.

Mr. E. C. Robins (London) thought neither architects nor engineers generally were properly qualified to deal with these matters at present, and he advocated a system of examinations before admission to the profession. The City of London guilds were giving practical teaching to workmen.

Lord Fortescue was glad to hear that the Society of British Architects had taken steps to hold examinations before admission to their body. He could not conceive the gross ignorance that in old times was displayed by architects of ability, and who had a great name; therefore he was not surprised to hear what Mr. Burdett had said. He hoped and trusted the Engineers' Institute would recognise it as a duty they ought to perform to test the capability of persons entrusted with the execution of sanitary works. Unless this were done, thousands and tens of thousands of pounds, instead of benefiting the community, would be wasted. Referring to the appointment of inspectors and other officials of that class, he said that one of the melancholy parts of local self-government was the extent to which it led to local jobbery in the appointment of officials. In one case, he knew, it was used as an argument in favour of a man desirous of trying his 'prentice hand at sanitary matters, not that he was himself a 'talented young townsman,' but that he was the relative of a townsman. He thought the Local Government Board might refuse to sanction appointments unless some *primâ facie* evidence of fitness was produced. He was glad to find that one of the objects of the Sanitary Institute was to test the capabilities of public officers, and to urge the advisability of examination being compulsory. Another important matter was to get workmen and foremen to understand how nearly the life or death of those who were going to live in the houses they built were in their hands. He had known most scandalous work for the sake of some paltry plunder, or because it should be done over again: that was to say, men did things badly with the idea that they were 'making work.' Men who would be shocked to give a blow that would injure a fellow-creature, would yet carelessly follow that abominable principle, and, in order to make work, endanger the health of the community.

Mr. J. DIXON (Winslade) thought it too much the practice of architects in building houses to consider the connection of drainage and soil pipes as subsidiary matters, and leave the plumber to put his pipes as he thought fit. Divided responsibility, as they knew, was no responsibility, and he thought the architect was the man who should be able to say that the structure was sufficient and adequate for all sanitary purposes.

Mr. HENRY C. BURDETT said he had been much gratified by the discussion, because he hoped that its influence would radiate far beyond the confines of that room by means of the press, and that one result would be that there should follow immediately a marked improvement in the work of the engineer and architect, with the result that justice to the public would be done. If that justice were done, then his purpose would be achieved. As to the arrangements by which local officers were appointed, he might recall the attention of members of the Institute to the fact that the Institute endeavoured to get recognition from the Local Government Board to its certificates to inspectors and surveyors after examination. The Institute had appeared twice in deputation before that department; but it transpired that there were difficulties in the way which it would take some time to remove. The Institute would, however, not lose sight of the matter. He would now bring the meeting back to the dangers of occupying new hospital buildings arising from the work which had been badly done. He was sorry to say that cottage hospitals were getting as subject to the evil of bad drainage as others, from the fact that the old cottages with their outside middens were being replaced by specially erected cottage hospitals with sewer gas laid on from a closed and unventilated cesspool. This was one of the dangers of over prosperity. It would be far better to occupy the old cottages than to transfer the patients to these insanitary, though specially erected cottage hospitals. He trusted that what had been stated would lead to improvement in these matters.

The PRESIDENT, in putting the vote of thanks (which was carried *nem. con.*), pointed out that much of the unhealthiness of hospitals, which had been built in the last century on a good plan, arose from the ignorant action of administrators in later times, in filling up with additional buildings the space wisely left by the original designers as a means of circulation of air round the edifice. He cited as a well-marked example the case of the Norwich Infirmary.

Sanitary Blunders and Practical Schemes for their Removal.

Every great reform, whether moral, social, or political, has been effected by a series of experiments more or less elaborate and costly, always attended by failure involving heavy loss, and the necessity of finding other means of carrying out the desired end. One remarkable fact in connection with almost every great change has been the adoption of the most complicated and difficult methods of obtaining the desired end, and it has only been discovered after repeated failures that success lies in the adoption of some of the simplest ideas. This peculiarity has attended the efforts put forth to bring about the much-needed sanitary reforms, and after years of experiments and the expenditure of enormous sums of money, the sanitary arrangements of our cities, towns, villages, and private residences are as defective as it is possible to conceive. Men of marked ability and of scientific knowledge have devised and adopted schemes, which have been carried out at the ratepayers' cost, only to be proved inadequate to remove the evils complained of, and to-day we have the very earth on which our cities and towns are built impregnated with the poisonous exhalations and gases which our engineers have tried in vain to confine in the sewers which intersect our streets in every direction.

Finding their efforts useless, they have of late advocated ventilation, and provided methods for effecting the same.

To show the need of reform, it may be permitted to examine the present systems adopted for ventilating our drains and sewers. Of course in the main sewers ventilating shafts are now adopted, but that they are quite inadequate is proved by the necessity of adopting some other means in every private house where the inmates value health and possess the means of applying the same. It is in the schemes adopted by private individuals that such strange complications are to be met with, and such a variety of plans carried out, proving that those whose business it is to execute this class of work, as well as those who employ them, are utterly ignorant of the elements of sanitary science. To begin at the lowest round, we see a pipe carried from a D trap, or soil pipe, not larger than three-quarters of an inch in internal diameter, to the roof, and this is supposed to obviate the evil of allowing sewer gas to enter the house. Generally speaking the upward current of air through this miniature outlet is entirely prevented by sealed traps above and below its position in the pipe supposed to want ventilation. This state of things in constantly to be met with in some of the best residences, the inhabitants confident that they have applied the best known means of preserving health from invasion by this source of disease. And it is very rare indeed that we find any departure from this system, the only improvement being an increase in the diameter of the ventilating pipe to, say, two inches; but in nine-tenths of the applications the water seal traps are adhered to, and consequently a free air passage is impossible.

But the great defect in the system of ventilating cowls is that when we want our sewers purified the most, viz., when the weather is excessively hot and close, and not a breath of air can be felt, they cease to work, because the motive power on which they depend (the wind) is absent. There is no system which can be depended on in all temperatures and at all seasons to remove the gases which are continually being thrown off, and more especially in the hot summer months. I will now give my idea of what is required to perfect these methods of sewer ventilation. Every sewer and every drain running into it from every source should constantly have a quick free passage of air passing through them in such a volume that every foot of surface should be acted on continually by that best of all vehicles for removing and dispersing offensive and dangerous collections of gases, which now fill the sewers and seek admission into our living apartments by every possible channel—the atmosphere. There should be no trap required or allowed in street or house, in bedroom, lavatory, or scullery; but there should be common open grids with air constantly passing through them as freely as the liquids they are constructed to carry away. To effect this in our towns and cities we have only to make use of means at present existing, and I need only mention them to prove at once their efficacy. The working details will readily be supplied by every practical engineer. Instead, then, of deploring the existence of steam boilers with their roaring furnaces, of gas-generating furnaces with their constant and intense heat, and other such fires where a continual consumption of fuel is taking place, as so many checks to sanitary reforms, let us make use of their enormous demands for air to keep up combustion, and compel them to take their supply of air direct from our sewers. Not only would the demand exhaust the foul contaminating gases there confined, but the continual rush of air to these furnaces would carry with it all fever germs, to be for ever rendered harmless by the fiery ordeal through which they would be compelled to pass; whilst through every open grating in street and house the purer air would pass to supply the place of that exhausted.

Some will say, 'Your plan can only operate where such facilities exist; in the best parts of the towns such means could not be found.' But there the same principle can be adopted. All practical men know that in the kitchens of our large houses large fires are constantly going, and the whole of the brickwork gets heated. Behind these fires chambers may easily be formed communicating with the drains, and in these chambers the air would be rarefied by the heat, and a perpetual ascending current would be the result, exhausting night and day the impure air of the drains, and effecting beneficially the ventilation of kitchen and scullery. And this arrangement would apply to isolated country houses and all positions.

To further perfect this system, let a bye-law be passed by the Board of Works, making it imperative that every new building shall have a ventilating shaft constructed immediately behind the kitchen chimney, and in connection with the drains, and as large in area as these drains are, so that every dwelling in that way should independently aërate and purify its own sewer arrangement.

The plan here proposed is not complicated; it depends for its successful working on heat, which every habitation requires every day; it involves no other demands than bringing into practical use the heated surroundings of every kitchen fireplace. In the case of private houses and localities where the first-named facilities for the wholesale purification of the sewers does not exist, its adoption will prove an incalculable blessing, for it will exterminate an enemy which has continually conspired to undermine and destroy one of his most valuable possessions, health.

RICHARD LEE, JUNR.

Forty Cases of Illness following Sanitary Neglect.

THAT the neglect of decent arrangements about human dwellings can possibly cause disease, is, strange to say, a truth still unadmitted by many of the community. With some this is due to ignorance or indifference; with others to self-interest, because it would cost them money or trouble to put things straight. Some people stand up for individual or corporate rights. Liberty of the subject is made to confer the privilege of cherishing small-pox in one's house, or any accumulation of filth, or other insanitary arrangements, on one's own ground. One man claims a prescriptive right of drainage into the next open ditch; another thinks it very proper to pile up stable-manure under his neighbour's windows; another has a vested interest in bone-crushing, rag-sorting, soap-boiling, candle-making, or some other process that poisons the air. Such a man feels bound to maintain in its existing condition some low and miserable but lucrative house-property; and such another man has on that spot an established right of horse-pond, which none may touch. With these persons you cannot argue; the law may now and then do so with effect, but not always; and there are many sanitary duties which are private and personal, with which it is not the province of the law to interfere. But it is possible by perseverance to convince the ignorant, and to build up and maintain a certain public opinion on the subject, by accumulating and setting forth instance upon instance of the production of disease by the neglect of sanitary measures. It is to contribute towards this that I submit the following cases from my own personal experience.

1. Several boys in a school of a superior class were attacked with fever. There were three or four severe cases, and one death. Large cesspools existed close about the foundations of the house, and bad smells were at times perceived.

2. Two cases of fever were received into a hospital. Similar cases had often been admitted, without any bad effects. But on this occasion the fever spread. Four persons, if not six, died, and about four more were dangerously ill. Bad smells had been noticed about the house; and shortly after the fever, it was discovered that several enormous cesspools, full of fœtid matter, were under the foundations

of the house, and that one of them in particular sent its vapours through numerous openings into one of the rooms.

3. A bad case of phlegmonous erysipelas was admitted into a London hospital. The patient stated that nine days before, a large sewer, passing under her house, was opened; and in the afternoon of the same day, she was attacked with shivering, which recurred for two or three days, when phlegmonous erysipelas came on. This patient died.

4. A lady died of fever in a house the drainage of which was supposed to be perfect. I examined the premises. On entering the back-yard, I was instantly sensible of a strong offensive smell, and on looking round for its cause, discovered a large open grating, communicating directly with one of the town sewers. This grating had never been noticed, and no doubt had emitted the poisonous miasma, which must constantly have entered all the back windows and doors of the house. Further search disclosed a long rat-hole opening beneath the dining-room floor and passing directly into the same sewer. These and other matters were immediately put to rights, and no further illness arose.

5. A lady in London had low fever, which ran a very lingering course, ending in recovery. She had often been annoyed with offensive smells coming from the back of the house, believed to arise from a cow-yard.

6. A case of low fever occurred in a sea-port town in a house near the quay. The town was drained into the harbour, and the mud at low water all along the quay sent up a considerable stench. The streets and alleys of this town abounded in cesspools and accumulations of filth; and fever was very common.

7. A case of febricula also occurred there in a young man engaged in breaking up a dirty old ship.

8. An infant was attacked with capillary bronchitis. He lived in one of a nest of cottages belonging to an owner too poor to keep them in order, and there were abominable collections of filth. The disease became asthenic, and the child died.

9. A father, mother, and several children, were all successively ill with inflammation of the mouth. Their cottage was absolutely without either ventilation or outlet both at the sides and back.

10. A woman with phlegmonous erysipelas, caused by smells from a cesspool.

11. A child with low bronchitis and canker of the mouth, died. The residence was over a stable, and the smell of stable manure was constantly present in the rooms.

12 to 30. Bronchitis, fever, &c., connected with foul air.

The cases from No. 7 to No. 30 were dispensary out-patients visited at their own homes. In each there was distinct exposure to sewer gas, emanations from cesspools, or the smell of stable-manure—which last I have always noticed to be highly deleterious.

31. Child with diphtheria. On entering the house, the smell of sewer-gas was instantly perceived; and on inquiry, it was found that the bell-traps had been removed from two sinks, and had so remained for some days.

32. An artisan came to me with sore throat. After inspection, I told him it was caused by sewer-gas. He assured me the drains, &c., were in perfect order in his house, and that he was excessively particular about such matters. After a few minutes, he suddenly recollected, that several days previously he had been employed for some time in putting a lock to a door, where there was an offensive smell as from sewers, which annoyed him and seemed to get into his throat.

33. A young lady was ill for some days with asthenic bronchitis, after being exposed to emanations coming in at a window from a dust-hole which the dustmen had neglected to clear out.

34. A tradesman's wife was several times ill with asthenic bronchitis, from breathing exhalations from a refuse-heap.

35. A gentleman was attacked with tracheal catarrh, partly from getting wet, partly from breathing foul air arising from the mud of a tidal estuary and offensive emanations from a brook into which house-drainage fell. A lady was severely ill with influenza, brought on by the smell of the mud of a harbour at low water, to which smell she was once exposed for a few hours.

36. For some years the young children of a small tradesman were attacked once or twice a year with erysipelas of the head or face, sometimes one child, sometimes another. The closet, as usual, adjoined the house at the back, and I have no doubt that emanations from it got into the house.

37. During many years the children of a wealthy farmer were frequently ailing, though without any distinctly zymotic illness. Large farmyards were close to the house, around which the smell from manure, &c., was usually perceptible. I do not doubt that in this case, some of the illnesses were caused by these emanations, though this could never be ascertained with certainty. I was of a similar opinion respecting several other families, but could not trace anything out to act upon.

38. An infant, frequently ill with one ailment or other, lived in a house at the foot of a hill. The drainage was suspected, but not known, to be wrong. The child was moved to another house a little way up the hill, and from that time was always well and hearty.

39. An infant was ill with canker of the mouth, brought on by foul air and bad food.

40. A gentleman requested me to see his coachman, who was ill with fever. He was living in well-appointed rooms over the stable, which was carefully ceiled ; yet the smell of stable-manure pervaded the whole place, and I have no doubt helped to cause his illness. A flydriver's wife, living in rooms over a coach-house, was suffering from low fever, which I attributed to the smell of stable-manure. In several other instances it has appeared to me that serious illness was caused by living over stables. A gentleman in London was made ill by the smell from the stable which penetrated into the dwelling-house.

One more case I must give. A gentleman was confined to his bed with a fractured patella. About the sixteenth day he was attacked with pneumonia, for which no other cause could be traced than the emanations from a neighbouring water-closet. The door of this was generally left ajar, and the place had, as usual, but a single window for ventilation. A somewhat similar case occurred with a woman in child-bed, mild fever being the result.

These are but samples of much more that could be given. It is not safe to believe that the first rudiments of sanitary science have been sufficiently taught. There are many people who either do not know them, or, what is even more frequent, do not attend to them and carry out their teachings. Cesspools are not yet things of the past. Refuse-heaps, manure-heaps, offensive trades, crowded collections of animals, yes, even sometimes of human animals, are not yet swept away. They are sometimes hid round corners, and in nooks, towards which the eyes of inspectors do not always seem to bend. I have seen nuisances, years ago complained of and supposed to be removed, still existing, and nearly in the original state; sanitary evils, long pointed out, not yet remedied; nuisances, which the arm of the law ought to have long ago reached, but which it seems to have no power to interfere with. In short, considering the talk and stir about sanitary matters which has gone on for these thirty years, and allowing for good things done and arrangements made, it looks as if some localities were not much the better for it all. It may be that health officers do not find themselves sufficiently free to do their whole duty. It is certain that some of them are very insufficiently paid. And it is also certain, that sanitary measures are not yet supported by the voice and vote of the whole community, and that both the knowledge and the disposition to do these things rightly are not yet possessed by all.

W. E. C. Nourse, F.R.C.S.

On the Past and Present Prevalence of several Diseases, as influenced by Food, and by House Drainage.

The following remarks relate to the causation and prevention of diseases, the object of all sanitary work. This kind of work is, we know, of quite recent origin; some of us may have helped, in our day, to develop it; yet, long ago, before the work or its name was thought of, the progress of human improvement did something to banish disease.

Thus, during the middle ages, leprosy was so common in the British Islands, that leper-hospitals were founded everywhere, and their sites are still known by the name 'Spital.' Leprosy receded and grew less common, according as improvements in agriculture and horticulture, and in the rearing of live stock, furnished better, more regular, and more abundant supplies of food, both animal and vegetable. Fresh food began to be more easily obtained; it was less necessary to live upon salted or dried provisions. And as by degrees the art of food-producing became more perfect, leprosy disappeared; first from England, afterwards from Ireland and Scotland; lastly, from the Orkneys, Hebrides, and Shetlands, lingering longest precisely where the methods of raising abundant regular supplies of fresh food were least practised, and still causing cases of the disease among people who were unable to procure such nutriment. Very rarely, a case of leprosy in a person who has never been out of England still occurs. One such case is recorded by me in the 'Medical Times and Gazette,' for September 2, 1865, page 251. But the present rarity of leprosy, contrasted with its frequency in time past, forcibly reminds us of the value and importance of good, fresh food, in the maintenance of life and health, and in the prevention of disease.

A similar lesson is taught in the history of a small parish in Sussex. Fifty years ago, ague was prevalent there; but lately, and for some years past, it has never been heard of. The disappearance of ague is usually attributed to the draining and reclaiming of marshes; but there is no marsh in or anywhere near this parish, nor has any alteration been made in the surface of the land. But there has been a material change in the condition of the people. Their standard of living has been improved, both by the rise in wages and by the increased demand for day-labourers. Fifty years ago, men were frequently out of work there during the winter, and their families were almost without food; parish relief had to be given them, and landowners employed them in planting waste land. A riotous mob burnt a threshing machine in the parish, because 'it took the poor man's work away from him.' But now, side by side with the introduction of all sorts of machinery into farm-work, it is very difficult to obtain a labourer. I believe the disappearance of ague in that parish, which is intimately known to me, is owing to the people being better fed than they were fifty years ago, and therefore being unaffected by the slight malaria, which arises from woods and fields in most country places, which diluted malaria, when formerly the people were not so well fed, gave to a certain per centage of them ague. It is likely that the history of many English parishes would furnish similar instances.

Thus may, and does, good food keep off disease, both ague and many other kinds, by so upholding the strength that well-fed persons exposed to deleterious influences are less frequently made ill by them. Proper food also banishes leprosy, scurvy, and diseases of that stamp, in a way more direct, by improving the condition of the blood. Well-nourished people recover from illnesses, which carry off persons who are under-fed. These things point out to us the enormous value of extended and diversified means of abundant food supply, and of doing everything to cheapen good food, to bring it within reach of all, and to make generally known the best modes of preparing it. No sanitary measures can equal this. The food question stands first. The introduction of every new article of food; quicker or more plentiful methods of raising food; the making two ears of corn grow where one only grew before; the teaching of cookery; improved ways of preserving food, of making it portable, and of transporting it; and the establishment of food-museums in large towns; all these are a boon and benefit to mankind, and tend to banish pestilences and epidemics, and to minimise sickness and mortality. Feed a people well, and they can defy an astonishing number of sanitary errors. Diminish their food, no matter by what means, whether by scarcity, or by want of money to buy, or by indulgence in alcoholic drinks or other matters that destroy appetite, and straightway they fall victims to the miasma from drains and cesspools and refuse-heaps, to want of ventilation, and to every other sanitary blunder.

I question if some of our supposed domestic improvements be not sanitary blunders. Every house must now have within it a place with water-pipes and machinery, which years ago were not needed in the small edifice at the end of the garden which then served the same purpose. These pipes communicate with drains, and are neither more nor less than conductors into our houses of poisonous gases, which our forefathers, with all their shortcomings, kept at arm's length. I repeat, they are conductors of miasma into our houses; for, however well-constructed they may be, they cannot be always perfect; and every slight leakage, every little derangement of valves and levers, every deficiency of water, and also the carelessness of those who use them, may and does occasion some ingress of bad emanations into our dwellings, the effects of which, in causing illness, every medical man of experience has observed. The same applies to indoor sinks. It is since these triumphs of the plumber's art have come into general use, that typhoid and diphtheria have been frequent in this country. Forty years ago these diseases were scarcely heard of. Typhoid was not known by name, though the researches of Broussais had pointed out a typhus-like fever which yet differed from typhus. And though now and then cases of this typhoid, better named enteric fever, were met with, still at that date, even allowing for its not being always recognised, it was not nearly so frequent as at present. It is supposed by many that diphtheria was then unknown. It was certainly very uncommon; very few medical men had seen it; but of late years it is only too frequent. Now, the increased frequency of these two diseases manifestly accompanies the general introduction and use of water-closets within our houses, an arrangement well known to have caused diphtheria, typhoid, and other illnesses in numerous instances, by some part of the apparatus getting out of order, and occasioning contamination either of the air or of the drinking-water. Obviously, there can be now no need to enumerate cases in proof. That it is so, will be conceded by all who are conversant with sanitary affairs; and those to whom the matter is not so clear can soon convince themselves by reference to recorded instances. But what I wish, in conclusion, to direct attention to, is the custom of late years adopted, of introducing into every house a tube which communicates with drains, and the prevalence of typhoid and diphtheria since this custom became general. Indoor closets should only be used when necessity compels; and the arrangements connected with them, which are generally very defective, should be wholly altered. Every such place should have two windows or apertures so as to cause a constant thorough draught through it, and should also be efficiently shut off from the rest of the house by a closely-fitting door. Till all these points are attended to, which they most certainly are not at present, preventable illness, of more or less serious character, will constantly occur.

And now, having mentioned in the first part of this paper the importance of augmenting our food supply in every direction, I will add a word on the subject by way of appendix. Respecting animal food, what reason is there why our main supplies of meat, now so high in price, are to be derived only from the sheep, the ox, and the pig? With all our zoological information, can we think of no other animal, besides these three, that is adapted to furnish a meat supply for ordinary use? Because the experiment with elands, and with one or two others, failed, can nothing else be tried? It is easier to ask these questions than to answer them; yet that is no reason why something should not be done. The kangaroo, the wombat, many sorts of deer and animals allied to them, the bison, the zebu, the camel, and others, furnish excellent food. We hear much of horse-flesh; it is also said that the meat of donkeys and mules is good. It is a pity the reindeer cannot be utilised in England, for its flesh is excellent. Fish-culture, again, is yet in its infancy, and might be widely extended, and made to include the better sorts of shell-fish. Hundreds of tidal estuaries now lie idle, which might be turned to some useful purpose in connection with this. Respecting vegetables, again, and cereals, it is astonishing, considering the hundreds of thousands of species in botanical lists, that so few kinds are appealed to for human food. Small supplies of new descriptions might be obtained from many plants now neglected; but the great gain would be if anything were discovered to add to our main crops, to stand side by side with wheat or the potato. Having seen something of the Irish potato famine, the deserted villages and roofless cottages, the ground torn up around them to gather roots to boil for food, and the fields of good land lying waste which no one dare till or put stock on, I am deeply impressed with the importance of not trusting to one or two species from which to raise food, but of putting in requisition as many kinds as possible, both of plants and animals, to furnish this first essential for the health of the people.

W. E. C. Nourse, F.R.C.S.

Mr. White (London) said he should like to ask a question with special reference to the village in Sussex, in which fifty years ago the people were subject to ague and such-like diseases. He was informed that these diseases had been in great measure remedied by the better provision made for the population. He should like to ask if it was not the case that there had been a material change in the structure of cottages in the ague districts of Kent and Essex. In the old days, when the cottages were almost exclusively on the ground, the absence of ague was never known; but as soon as the cottagers began to live eight, or even six feet above the ground, these symptoms disappeared. He should like also to know as to the soil, and whether its tenacity was such as to hold the water and throw off injurious exhalations. As an instance of the effect of sewer air, he mentioned the case of poisoning at Welbeck, where a number of persons were poisoned by partaking of sandwiches made from a ham kept in a larder in which there was communication with a sewer.

Dr. TAYLOR (Norwich) said he thought that *per se* sewer-gas was credited with more disease than it was accountable for. Berlin, as they knew, was a city of stinks, and during his residence in that place he believed that he had breathed more sewer-gas than anyone who resided in a more sanitary country. But on no occasion had he suffered from typhoid and other diseases, which in this country were attributed to the action of sewer-gas *per se*. He had come to the conclusion that there was little evidence that impure water and air were capable of producing such diseases as was said. Whilst in Berlin his bedroom was surrounded by courts, in which were stables, wells, and closets; and the state of the atmosphere in his room was at times such that he could not see. He was also a rigid water drinker, but during his stay there, although he had drunk water undoubtedly polluted, he never suffered from typhoid fever or other diseases attributed to sewer-poison.

Mr. CHADWICK said the statistics of Berlin were an answer to Dr. Taylor. In going round the city they would find that the proportions of overcrowding and other conditions with the death-rate corresponded. The results of his examination of the statistics as to Berlin showed that the result was quite in accordance with what was met with everywhere, that insanitary conditions of living raised the death-rates and the prevalence of disease.

Mr. KARKEEK expressed his surprise at hearing remarks which implied that sewer-gas and polluted water were not dangerous. He was surprised at Dr. Taylor's remarks, pointing to Berlin as a sanitary city, as his own experience there had been quite the contrary.

The PRESIDENT said that Dr. Taylor did not say that sewer-gas was innocuous, but that he had lived in Berlin, had breathed sewer-gas and drunk polluted water, and was not affected.

Mr. TOWLE (Oxford) remarked that in Berlin 28,000,000 gallons of water were every day pumped thirty-eight feet high, and flowed into the city. That must cause a lot of dirty water, which was conveyed miles away from the city. That was his system to a certain extent, but by his system they also got rid of the solids. If these 28,000,000 gallons of dirty water could be dispersed over the hills round London, and over the downs, what a benefit it would be! At present the country was being ruined by the sewage being sent into the sea.

Mr. PENGELLY (Torquay) agreed that too much was attributed to impure air and water, and not enough to germs of disease, which were liable to be overlooked.

Dr. CARPENTER said he agreed with Dr. Taylor that sewer-gas *per se* would not produce specific disease, but where they had bad sewage arrangements they could not have pure health; and they knew that it was in the sewers that the germs of disease were created, and that where the gas went the germs went. If Dr. Taylor was not struck by them, so much the better for him. But in a similar way a man might be in a battle without being hit: the bullets would be none the less a fact, however. If they had no sewer-gas, there would be no vehicle by which these germs could be conveyed.

Mr. NOURSE, in answer to the question as to the houses in Sussex, said that in 1844 or 1845 they were rebuilt, and that, and the better food which the people were able to obtain, had doubtless much to do with the altered state of things.

Means of Prevention and Cure of Hydrophobia.

The PRESIDENT announced that Dr. Richardson had sent in a translation of a paper, by a French gentleman, on 'A Proposal of Measures for the Prevention of Hydrophobia.' This paper, by M. Decroix, was sent in French. The following is an abstract of the chief points. He starts by observing that every case, or nearly every case, of madness in dogs can be traced to a bite from another dog. Starting from this principle, M. Jean Bourrel has proposed to prevent the disease by cutting or filing dogs' teeth in order to render it impossible for them to bite. Experiments were made by shutting up mad dogs with other dogs in cages, and allowing the former to bite the latter, the skins of which were found lacerated and pierced. The mad dogs then had their teeth filed and cut, and a similar experiment was made. Although the healthy dogs were attacked the skin was not broken. The writer further states that the process of filing and cutting the teeth is neither painful nor unsightly.

In the second part of the paper the writer upholds the tendency of the disease to proceed (at least sometimes) to spontaneous cure; and he recommends that both animals and men afflicted by it should be left alone, and not agitated with attempts at cure, or palliation. The only measure he recommends is the vapour bath.

The Necessity and Importance of Mortuaries for Towns and Villages, with some suggestions for their Establishment and Management.

The subject of mortuaries is one that has received by far too little attention, not only at the hands of those who are responsible for the practical carrying out of the public health laws of the kingdom, but even of ardent sanitary reformers. Yet it holds, or ought to hold, a prominent place in preventive medicine; and it differs from other sanitary appliances in having an important moral and social office as well as a hygienic one.

To an assembly like this it might perhaps be considered superfluous that I should attempt to show cause why mortuaries are necessary or desirable. Most of us, and especially those whose work has brought them into relations with the poor and the degraded, know what additional terrors death brings with it when it occurs in wretched tenemented property, or in overcrowded cottage homes, where the same room has to act as dead-house, living room, work-room, and not infrequently bedroom. In the poorer parts of our great towns, and, to a lesser degree, perhaps, in country villages, scenes of the most harrowing and saddening description are constantly being enacted through the unavoidable presence of the dead in the midst of the living. Perhaps no more striking demonstration of the need for mortuaries has been made than in the writings of one who is well known to and honoured by all of us—our veteran vice-president, Edwin Chadwick. It is to him that we owe, more than to anyone else, that sanitary awakening which has now become so general and wide-spread, and of which one of the strongest evidences is the existence and success of this Institute. Mr. Chadwick, to whom had been committed early in the present reign the task of collecting information about the sanitary state of the country, and subsequently as to the practice of interment in towns, wrote as follows in the year 1843[1]; and his words are equally applicable at the present moment:

'In a large proportion of cases in the metropolis, and in some of the manufacturing districts, one room serves for one family of the labouring classes: it is their bedroom, their kitchen, their wash-house, their sitting-room, and their dining-room; and when they do not follow any outdoor occupation, it is frequently their work-room and their shop. In this one room they are born, and live, and sleep, and die, amidst the other inmates. . . .

'It is not a few minutes' look after the last duties are performed

[1] *A Supplementary Report on the Results of a Special Inquiry into the Practice of Interment in Towns.* By Edwin Chadwick. London. W. Clowes & Sons, 1843.

and the body is composed in death and left in repose, that is given to this class of survivors, but the spectacle is protracted hour after hour through the day and night, and day after day, and night after night, thus aggravating the mental pains under varied circumstances and increasing the dangers of permanent bodily injury. The sufferings of the survivors, especially of the widow of the labouring classes, are often protracted to a fatal extent. To the very young children, the greatest danger is of infection in cases of deaths from contagious and infectious disease. To the elder children and members of the family and inmates, the moral evil created by the retention of the body in their presence beyond the short term during which sorrow and depression of spirits may be said to be natural to them is, that familiarity soon succeeds and respect disappears. These consequences are revealed by the frequency of the statements of witnesses, that the deaths of children immediately following, of the same disease of which the parent had died, had been accounted for by 'the doctor,' or the neighbours, in the probability that the child had caught the disease by touching the corpse or the coffin whilst playing about the room in the absence of its mother. The mental effects on the elder children or members of the family, of the retention of the body in the living room day after day, and during meal times, until familiarity is induced—retained as the body commonly is during all this time in the *sordes* of disease, the progress of change and decomposition disfiguring the remains and adding disgust to familiarity—are attested to be of the most demoralising character. Such deaths occur sooner or later in various forms in every poor family; and in neighbourhoods where there are no sanitary regulations, where they are ravaged by epidemics, such scenes are doubly familiar to the whole population.'

The same graphic pen thus writes in the report of the Board of Health on a general scheme for extramural sepulture, published in 1850:—

'The connection between the extinction of the feeling of respect for the dead and the growth of that callousness which renders the brutalised mind insensible to the sacredness of life, and which thus prepares it for the perpetration of crimes of violence of the greatest enormity, has been often traced by those who have had the best opportunity of witnessing the process; and they concur in stating that it is in these filthy, unwholesome, and crowded rooms, where none of the observances of decency are regarded, and where the living, without emotion or concern, eat and drink and sleep in the presence of the dead, not only that the degraded and profligate who constitute the ordinary pests of society are trained, but also that it is out of those same abodes that our great criminals generally come, brutal and reckless men, who every now and then perpetrate in cold blood, with a savage callousness, deeds which fill the whole country with disgust and horror.'

I do not quote any of the instances which Mr. Chadwick cites, on the authority of clergymen and undertakers of that period, of the distressing scenes that they were constantly called upon to witness where a death occurred under conditions that absolutely precluded any separation or screening of the dead from the living. It might be argued that a generation, and the passing of numerous sanitary Acts of Parliament, have worked a revolution in this respect since Mr. Chadwick's glowing words were written. I can confidently affirm, however, from a pretty large experience of the slums of London and of other towns, that scenes not a whit less distressing or heartrending than those described forty years ago are still matters of common experience among our poor and degraded neighbours.

I feel bound, in justification of the position which I have assumed, and in order that I may not seem to be speaking without book, to cull a very few from the large number of instances that have come under my notice in one way or another, pointing to the necessity and importance of mortuaries. They are instances which every health officer, and every one who moves among the poor, could multiply a hundred-fold.

Cases of the kind to which I am referring are constantly occurring in the experience of London coroners, whose evidence on this subject would be of the most instructive and startling kind. The dead body of a woman on whom an inquest was held by Dr. Hardwick in 1876 was kept in a miserable underground kitchen where the family lived; and where, after the work, the family slept and took their food by the side of the corpse until the burial took place.[1]

In a speech made before Mr. Sclater-Booth, in January 1876, Dr. Joseph Rogers cited the following case: An old man died in a house in St. James's let out to lodgers. As it was thought his friends would bury the body, it was allowed to remain several days: indeed, until decomposition had so far advanced as to fill the house with effluvia. The sanitary inspector was then applied to, who, in his turn, applied to the master of the Westminster Workhouse for permission to take the body to the workhouse dead-house. The body was so putrescent that the workhouse attendants had to fill the shell with charcoal ere they dared to take it through the streets.[2]

At a meeting of the West Derby Local Board in March 1876, the sanitary inspector reported that in the course of his duties he had visited a house on the 23rd, and had found the body of a woman who had died on the 19th, lying in one of the rooms which was used as the sleeping-room of the family. The husband stated that as he was too poor to inter the body, he had applied to the relieving officer to have it buried, but the request had been declined by the Board of Guardians. He then went to the clerk to the Local Board, who, after some delay, got an order from a magistrate, and the body was buried six days after death. The husband, who was represented to be given to drink, and indifferent as to whether the body was buried or not, had slept, it was said, in the same bed in which the corpse lay.[3]

The corpse of an unhappy youth at Milton-next-Sittingbourne, who died in a barge from typhoid fever, contracted through drinking

[1] *Sanitary Record*, 1876, vol. iv. p. 162.
[2] *Ibid.* 1876, vol. iv. p. 43.
[3] *Ibid.* 1876, vol. iv. p. 252.

polluted water, was brought to his parents' house through the streets in an open van. On the arrival of the body, the coffin was unscrewed, and remained so for two days before the burial. An outbreak of typhoid fever, confined to the street in which the body lay, subsequently broke out, and may possibly have been due to infection from the corpse.[1]

M. Kœchlin-Schwartz recently narrated to a commission of the French Society of Public Medicine—a society which has lately devoted much attention to the subject of mortuaries—a very painful case. In a small room rented by a workman, the father, attacked by small-pox, lay dying on the only bed, and round him, his wife and his five children, without fire or food, were waiting in despair till their turn came to be struck down by the disease. The mother, indeed, was in the anguish of child-birth whilst her husband was *in extremis*.[2]

Quite recently, in fact during the present month, two other glaring cases have been reported in the metropolis, where the great want of public mortuaries is being daily illustrated by the occurrence of cases shocking public decency and detrimental to public health. In one case, in which Mr. Humphreys held an inquest into the cause of the death of a labourer at Mile End, the jury having viewed the body, made, on their return, a complaint to the coroner of the unseemly sight which they had just been obliged to witness. The body lay in a very small and squalid room, in which the relatives, three in number, were sleeping, and had to be aroused before the jury could perform their duty. The foreman justly observed that such a state of things ought not to be permitted to exist in an enlightened country. The coroner's officer explained that there was no public mortuary in the parish of Mile End New Town, or he should have taken the earliest steps to have had the body removed. The coroner could only recommend the foreman to make a representation of the facts in the proper quarter. Dr. Hardwicke, the coroner for Central Middlesex, on the occasion of holding two inquests at the Hampstead Workhouse Infirmary, also called attention to the inconvenience which has long been felt by medical men and others having any connection with inquests at Hampstead, in regard to the want of proper mortuary accommodation. The building at present used for that purpose is the workhouse dead-house, situated at one of the extreme ends of that extensive parish, and is not properly fitted with appliances for post-mortem examinations. Dr. Hardwicke said he had been requested by medical men and others to draw the attention of the jury to this matter. It was thought that the time had arrived when they should make some representation to the parish authorities on this subject. The present mortuary was a place for paupers, and it was not proper that the bodies of those who were not paupers should be taken to it. The medical men engaged, too, had not the proper apparatus with which to do their work. Another grievance was that persons dying in a distant part of that large parish had to be brought to that place. If it were the opinion of the jury that a more central place should be provided, quite apart from the workhouse, he would offer a memo-

[1] *British Medical Journal*, 1879, vol. ii. p. 663.
[2] *Revue d'Hygiène*, tome ii. p. 41.

rial for them to sign. The jury agreed to this suggestion; and a memorial was drawn up and signed by the jurors and others, and is to be followed by another from the medical men of the parish.[1]

One more example, and I have done. There are few amongst those present who do not know the labours amongst the poor of the Rev. Septimus Hansard, the rector of Bethnal Green. On the occasion of the recent opening of a mortuary for his crowded parish in June last, Mr. Hansard said :—

'The use of the building was two-fold—(1) As a mortuary or morgue for the reception of dead bodies, suicides, persons found drowned, nameless corpses, &c. (2) As a mortuary chapel. It was impossible to have been as he had been—for the last 33 years a clergyman among the poor of London—without seeing the necessity for some such building as this, whither the inhabitants of the crowded dwellings of the metropolis might remove their dead, especially in times of epidemics such as cholera, scarlet or typhus fever. He gave three instances of such necessity out of many in his experience. In the time of the cholera, there was one night when nine lay dead of cholera in the houses of the church-close or square near the parish church. The people all sat about in the streets, too frightened to go to bed; and in one place they were burning pots of tar from the windows of the room where a corpse lay. Again, it had in the course of his ministry been his duty to attend two medical men on their death-bed who, in the fearless discharge of their profession, had fallen victims to confluent small-pox. On both occasions the relatives had immediately after death removed the bodies to outhouses. On another occasion he saw, in a room not larger than an ordinary closet, three victims of typhoid lying dead, with five people eating, drinking, sleeping, and living in the same room. Things like this in a professedly religious and Christian country were disgraceful. Here, surely, were proofs of the need of such a mortuary chapel as had just been opened. But not only in case of epidemics would this building be used, but at ordinary times. There were two rooms in the chapel, each capable of containing thirty coffins. One might be set apart for those which required an inquest, or for infectious bodies, the other for those brought thither by sorrowing friends, who could cover the coffin with a pall, and come and take their last look at their beloved ones, surrounded by the emblems of Christian hope. That was why he had desired the building to be called a chapel; not that masses for the dead should be said there, but to throw the sanctity of religion over the building.'

The experience of many of you will furnish other equally striking cases, and I need not, therefore, detain you further with citing more. All sanitarians agree in thinking that in large or crowded towns a properly constructed mortuary is of the first necessity: and there are reasons for thinking that in rural districts also, some provision of the kind would be extremely valuable and save much present scandal. The dwellings of agricultural labourers and their often indecent overcrowding need no description at my hands: and what is to be done in such when a death occurs? Evidently the dead must be left in very unwholesome and distressing proximity to the living in the

[1] *British Medical Journal*, 1880, vol. ii. p. 517.

absence of a mortuary or dead-house, which thus becomes a necessity throughout the country.

Having in this way attempted to place graphically before your minds the horrors and dangers of the dead remaining amongst the living in poor and wretched homes, I would now draw your attention to the remedy, viz. the provision of reception or dead-houses, in which corpses may remain pending interment.

The able and comprehensive report by Mr. Chadwick, to which I have already alluded, may fairly be considered as the starting point, amongst other things, of mortuaries. The report was published in 1843, and evoked much attention and discussion. With the exhaustive report which preceded it, on the sanitary state of the labouring population of Great Britain, it unquestionably paved the way for the passing of the Public Health Act of 1848. In that Act (11 and 12 Vict., cap. 63) there was a section (No. 81) which provided that for the regulation of interments in districts to which that Act applied, Local Boards might provide reception houses for the dead, and make bye-laws with respect to the management of the same, and on application, make arrangements for the interment of any corpse contained therein. This clause was practically superseded by section 27 of the Sanitary Act, 1866, but was not formally repealed until the Consolidating Act of 1875.

The law remained, as regards sanitary authorities, in this state for nearly twenty years, but meanwhile the subject had received a certain amount of attention both at home and abroad. In 1852 there was a general Sanitary Congress at Brussels, and part of the third question for discussion was: 'Of what utility are mortuaries, and for the cases in which their usefulness is recognised, how should they be organised?' I rejoice to find that amongst those who made a firm stand on that occasion for this question being one proper for discussion by the Congress (in opposition to those who would have ignored it, on the ground of its touching questions of religious feelings and family affection) our honoured President, then Lord Ebrington, made himself conspicuous. After discussion, the Congress declared the usefulness of mortuaries in each parish; and, on the motion of Lord Ebrington, resolved that: 'Convinced of the great evils of the keeping of corpses in inhabited rooms, the Congress declares the usefulness and earnestly recommends the establishment of mortuaries.'

Whilst as regards the provision of mortuaries by sanitary authorities no further legislation was attempted until 1866, an important addition to the law was meanwhile made by giving power to the Burial Boards established under the Burial Acts to provide such a building. Thus, section 42 of the Metropolitan Burials Act of 1852 (15 and 16 Vict. c. 85) gave power to any Burial Board, or to the churchwardens and overseers of any metropolitan parish for which a Burial Board had not been appointed under the Act, to 'hire, take on lease, or otherwise to provide fit and proper places in which bodies may be received and taken care of previously to interment, and to make arrangements for the reception and care of the bodies to be deposited therein.'

This power was extended to places beyond the Metropolis by section 7 of the Burials Act of 1853 (16 and 17 Vict. c. 134); to Scotland by section 20 of the Scotch Burials Act of 1855 (18 and 19 Vict. c. 68); and to Ireland by section 23 of the Irish Burials Act of 1856 (19 and 20 Vict. c. 98), now replaced by section 180 of the Public Health Act of 1878 (41 and 42 Vict. c. 52).

The Sanitary Act of 1866 (29 and 30 Vict., c. 90) improved the state of the English law as to mortuaries. By section 27 of this Act 'nuisance authorities' (equivalent to our existing local authorities) were empowered to provide a proper place for the reception of dead bodies, and thereupon a justice, with a medical certificate, might order bodies to be removed to it, and cause removal if the relations failed to obey, charging them with the cost. The authorities were also empowered to provide places for post-mortem examinations (section 28).

The Royal Sanitary Commission, commenting upon section 27, observed that 'although there is this power by law, it appears to be very little exercised, and the evil of keeping the dead in the same room with the living exists very extensively amongst the poor, and this evil is aggravated by the general practice of wakes among the lower classes of the Irish Roman Catholics, who are very numerous in some large towns, such as Liverpool.[1]

The Commissioners suggested that power should be given to the Central Authority to compel a Local Authority to provide a mortuary; and that, even when there was no mortuary, the justice should be enabled, in the cases specified in section 27 of the Sanitary Act, to give an order for the removal of the body from the house. To facilitate the acquisition of parts of closed burial grounds or of land in cemeteries for mortuaries, the Commissioners suggested that the Local Authority should be empowered, in the case of any closed burial ground, to purchase by contract any part of such burial ground from those in whom the site and control were vested, for the purpose of erecting thereon a mortuary, and (if needful) a residence for the keeper. The Commissioners formulated, however, certain provisoes to this transfer, and as these provisoes contain much suggestive matter in a small compass, I give them in full:—

'1. This shall not authorise the purchase of any piece of land if it necessitates the disturbance of bodies already buried.

'2. Nor if the piece to be purchased cannot be approached without passing through any other part of the closed burial ground.

'3. No religious service shall be held or celebrated in any mortuary erected in any closed burial ground.

'4. Such mortuary and residence house (if any) shall be separated by a wall or fence from the rest of the burial ground.'

The Consolidated Public Health Act of 1875, whilst re-enacting the sections of the Act of 1866 as to mortuaries, made their provision by the Local Authority compulsory in cases where the Local Government Board required. The Act of 1875 does not, however, extend to the Metropolis, which, in this respect, is worse off than the country, for the Local Government Board have not the power, even if

[1] *Second Report of the Royal Sanitary Commission*, vol. i. p. 50.

they felt inclined to exercise it, to compel the erection of a mortuary in London. In Scotland legal power is given by section 43 of the Public Health Act of 1867 (30 and 31 Vict. cap. 101) to provide a place for the reception of dead bodies, and to remove bodies to it in certain cases. Nothing is said, however, with regard to post-mortem rooms. In Ireland provisions similar to those in the English Act are contained in sections 157, 158, and 159 of the Public Health (Ireland) Act, 1878 (41 and 42 Vict. c. 52), and there is this important addition : 'The body of any person who has died of any dangerous infectious disease in any hospital or place for the treatment of the sick shall not be removed from such hospital, until removed direct to a mortuary or cemetery, and any person violating, or any officer of an hospital or other person who knowingly permits the violation of this provision, shall be liable to a penalty not exceeding five pounds.'

Seeing the unsatisfactory state of the law, Dr. Joseph Rogers, whose services in connection with sanitary work are well known, and who, some 24 years before, had the principal share in the establishment of the mortuary at St. Anne's, Soho, which was for several years the only one in the Metropolis, moved, in the year 1875, at the Strand Board of Works, that 'With the view of the more effectually and economically securing the establishment of mortuaries in the different parishes of the Metropolis, this Board do memorialise the Metropolitan Board of Works, urging that Board to apply for powers in the next Session of Parliament, authorising that body to undertake their erection in such parts of the Metropolis as may be considered necessary.' The Metropolitan Board declined however to take up the subject, on the grounds that the mortuary question is beset with difficulties in London, and is one which should be dealt with by the Local Boards and not the Metropolitan Board.[1] The Strand Board of Works deemed it necessary, however, to interview the then President of the Local Government Board, for the purpose of securing the aid of his Department in establishing mortuaries in different parts of the Metropolis. A deputation from that body waited upon Mr. Sclater-Booth in January 1876, when Dr. Rogers made a lengthy and telling speech in favour of the extension of mortuaries, winding up by formulating the points that should be attended to with reference to the question.[2] These were: '1. That it should be made compulsory on every Local Board to establish a suitable mortuary on a common plan, to be approved of by the Local Government Board or the Metropolitan Board of Works. 2. That these mortuaries should be in the proportion of not less than one to every 50,000 inhabitants. 3. That powers should be provided for the compulsory purchase of property under the provisions of the Lands Clauses Act, and for enabling parishes or portions of parishes favourably situated for such purposes to combine to form mortuary districts; such mortuaries to be maintained at their joint expense, and for their common use. 4. That the Medical Officer of Health, or the Poor-law Medical Officers, or the

[1] *Sanitary Record*, vol. ii., 1875, pp. 165 and 325.
[2] *Ibid.* vol. iv. 1876, p. 44.

Relieving Officer, should be empowered and directed to order the removal of a corpse to the district mortuary in all cases where it was found that the family, at the time of such death, occupied only one room, and in such other instances where it appeared desirable to these officials to direct the same.'

Not much of promise was extracted from Mr. Sclater-Booth: but he undertook to confer on the subject with Mr. Cross, who as Home Secretary had more control over the Vestries than the Local Government Board had. In the ill-fated Public Health (Metropolis) Bill of 1877, which Mr. Sclater-Booth introduced with the view of making the public health law uniform for the metropolis and country, clauses were inserted re-enacting the clauses in the Sanitary Act, 1866, bearing on the question, but making the provision of a mortuary compulsory, if the Local Government Board so directed. The fate of this Bill is, however, well known; and we are now in the Metropolis almost as badly off as ever, certainly as badly off for any reasonable system of disposing of the dead pending interment. I think, therefore, that this is a subject which is eminently worthy of the attention of the Sanitary Institute, and I would suggest for consideration, whether it might not be expedient and useful for the Institute to take up the question where it was left in 1876, and endeavour to induce the new Government to make a move with regard to this important branch of public health machinery.

I now come to the second part of my paper, and proceed to offer some suggestions for the establishment and management of mortuaries.

I must premise that these suggestions are not intended to exhaust the subject. They are suggestive merely, and are offered in the hope that they may help to a better understanding of a question on which far too little is known. Not the least of my difficulties in approaching this subject has been the extreme paucity of the information given about it by standard authorities.[1] The word mortuary hardly occurs in the index to any book on Hygiene with which I am familiar. I have therefore had to rely very much upon the facts which I have been able to pick up in the course of my reading, and upon my practical experience of the requirements of such erections.[2]

It may be, and has been, urged against the erection of mortuaries, that even if they were established, poor people would with difficulty be got to allow their dead to be taken there. The law recognizes this difficulty, and section 142 of the Public Health Act provides that 'when the body of one who has died of any infectious disease is

[1] *Sanitary Record*, January 15, 1876, p. 44.

[2] For much valuable information showing the need for mortuaries, reference may be made to Mr. Chadwick's *Report on the Practice of Interment in Towns* (Clowes, 1843), and to the Report of the General Board of Health *On a General Scheme for Extramural Sepulture* (Clowes, 1850). Dictionary articles on the subject will be found in Tardieu's *Dictionnaire d'Hygiene*, article 'Morgue' (Baillière, Paris, 1862), Wynter Blyth's *Dictionary of Hygiène*, article 'Mortuary' (Griffin, London, 1876); and Pappenheim's *Handbuch der Sanitäts-Polizei*, article 'Leichen-polizei' (Hirschwald, Berlin, 1870). In the second edition of the writer's book on *Cottage Hospitals* (Churchill, 1880), an attempt has been made to deal with the question of mortuaries, more particularly from the point of view of their relation with hospitals.

detained in a room in which persons live or sleep, or any dead body which is in such a state as to endanger the health of the inmates of the same house or room, is retained in such house or room, any justice may, on a certificate signed by a legally qualified medical practitioner, order the body to be removed at the cost of the Local Authority, to any mortuary provided by such authority, and direct the same to be buried within a time to be limited in such order.' This section, it will be observed, is of very wide application; for it cannot be doubted that many dead bodies, not necessarily those of persons dying of an infectious disease, are in such a state as to endanger the health of the living inmates of the house or room in which the bodies are retained. Yet, unless a mortuary is provided, there is no legal power to deal with the body, and it may remain a source of the gravest injury to the public health of the neighbourhood. The establishment of a mortuary is then an imperative duty for Local Authorities throughout the kingdom.

Mortuaries have been provided in this country in a great variety of ways. There are first of all the separate erections, with post-mortem room and coroner's court, such as the mortuaries in the City of London, at Islington, Clerkenwell, and in some of our large towns. There are the mortuaries provided by sanitary authorities in connection with infectious hospitals that they have established. There are the mortuaries provided at cemeteries or on licensed burial grounds. And there are the mortuaries, if such they can always be called, provided at general hospitals for the bodies of persons dying in the institution, but rarely thrown open to the outside public. Of the latter I do not intend to speak. These are not public mortuaries in any real sense of the word. They are simply furnished for the convenience and use of the hospital authorities and for post-mortem purposes, and are intended in addition for the purpose of keeping the corpses out of the wards until the time comes for burial. Indeed, it may safely be said that no mortuaries in any comprehensive sense of the word exist at hospitals.

Of mortuaries proper, all sorts and sizes exist, from the elaborate erection provided at a cost of 12,000*l.*, by the City Commissioners of Sewers, in Golden Lane, comprising a mortuary chapel, with twelve slate tables, keeper's house and offices, coroner's court, laboratory, weighing room, consulting room, dead-house fitted for post-mortem examinations, disinfecting apparatus, ambulance shed, and shed for disinfecting apparatus, down to the old parish dead-house or pest-house, which has in some places been utilised for the purpose, and is almost, if not quite, destitute of all furniture.

One of these pest-houses is to be found at Greenwich, where it stands in the churchyard, to the disgrace of the local health authority.

I do not propose, in fact it would be impossible for me, to attempt to give any sort of description of the mortuaries which at present exist. They are too various in establishment, size, arrangement, regulation, and management, to admit of any sort of classification; and I have therefore contented myself with giving in an Appendix the names, and all procurable particulars of those mortuaries of which

I have been able to learn the existence. I am conscious how extremely defective this list is, and I shall be greatly obliged for any further names and particulars with which I may be favoured.

I proceed then at once to sketch out certain requirements of a mortuary, as regards its establishment, situation, and regulation.

And first, as to its *establishment.* I have already mentioned in a former section that, under the Public Health Act of 1875, any Local Authority may, and, if required by the Local Government Board shall, provide a mortuary, and may make bye-laws with respect to the management and charges for its use. They may provide for the decent and economical interment of any dead body received into a mortuary (Section 141). To this mortuary, a justice may, in certain cases, order the removal of a dead body (Section 142). The Local Authority may also provide a place for post-mortem examinations ('otherwise than at a workhouse or a mortuary') (Section 143). Thus it is to local sanitary authorities that we must mainly look for the establishment of these temporary resting-places for the dead. But it has struck me that when the Local Authority is unwilling to perform this necessary duty, or has difficulty,—which I know to be sometimes a real difficulty,—in procuring a suitable site, that then another method might, in places where there is a hospital, be devised for securing the establishment of a mortuary. Most hospitals make some sort of provision for deaths occurring within their walls; and I think that if sanitary authorities felt disposed to help, hospital managers would often be found willing to erect a somewhat more pretentious mortuary than they would otherwise have done, and to throw it open, under certain regulations, to the general public. The rapid extension of cottage hospitals leads one to hope that this method of securing mortuaries would satisfy the demands of a large and increasing number of places. It is a common practice for Local Authorities to subscribe to hospitals,—especially to infectious hospitals,—provided by private enterprise; and I am not aware of any legal objection to the same power of subscription being exercised in the case of mortuaries. Indeed, the utility of a mortuary is usually more obvious to Local Authorities than that of a hospital, so that probably this plan has only to be suggested to secure adhesion to it.

Another method in which mortuaries—especially on the continent—are provided, is to erect them in *cemeteries.* There is much to recommend this plan, both on the score of economy and of regard for the public health, so long as the cemetery is within reasonable distance of the district for which the mortuary is to serve. Such mortuaries are of course provided by Burial Boards, who need not be, and as a rule are not, the sanitary authority of the place. In this connection, it may be worth while to observe that, whilst section 142 of the Public Health Act grants the power of compulsory removal of dead bodies to a mortuary provided by a sanitary authority, it does not do the same in the case of a mortuary provided by a Burial Board. This seems a very absurd and unnecessary restriction, and may be commended to the attention of our legislators. In addition to the advantage of freer space and cheaper administration,—for the cemetery-keeper could be instructed to supervise the mortuary as part of his duties,—mortuaries at cemeteries enable the corpse to be taken direct to the grave, without the necessity of a hearse and its attendant expenses. At the mortuary established by the Hampstead Burial Board at their cemetery at Fortune Green, there is a wholesome rule requiring that, in the case of persons dying of infectious disease whose corpses are received into the mortuary, the friends must meet the corpse at the cemetery, and not at the mortuary, from which the body is carried direct to the grave. For ordinary cases of death, it would be well to have a separate waiting-room provided for the mourners to assemble in on the day of burial, as is done at the mortuary in Dean Street, Soho. Seeing, then, the obvious advantages of mortuaries at cemeteries, it may be worth consideration whether, in the establishment of all new cemeteries, provision should not be made in the plans for a building, of the nature of a mortuary, to receive dead bodies pending interment. On this point, the evidence of the late Mr. Robert Baker, one of Her Majesty's Chief Inspectors of Factories, is peculiarly valuable. When examined before the Royal Sanitary Commission, on January 17, 1870,[1] Mr. Baker said that he 'wished strongly to express that he thought at every cemetery there should be a mortuary for from one to fifty bodies, with locks and keys, the numbers of the cells and keys to correspond: and he thought it would be desirable, in non-contagious deaths, that the bodies of the poor should be conveyed, soon after death, to these mortuaries, and, if the people were needy, at the public expense; and the key should be given up to the relatives to the time of interment, which should be fixed, in order to avoid offence in the summer time' (Q. 9407). Asked whether he would make the removal optional in non-contagious diseases, and compulsory in the case of contagious diseases, he answered in the affirmative; and he thought that 'in case of contagious diseases, it should be compulsory to have the body placed within a shell, within a coffin (if it be desirable that it should be kept for the arrival of friends), between which and the shell there should be an interstice of pitch; the lid of the shell being also pitched on, but with a glass over the face' (Q. 9408). The expense of such removal Mr. Baker would, in the case of poverty, throw upon the parish.[2]

We have next to consider the question of *situation*. Whenever possible, the mortuary should of course be separated by a belt of air from all dwelling-houses; but no injury has been found to follow the use of those in very crowded neighbourhoods, even when they abut on the street. The mortuary in Drury Lane, the walls of which are brought up flush with the pavement, is an instance of this. The

[1] *Second Report of the Royal Sanitary Commission*, vol. iii. Part I. p. 53.

[2] Mr. Thomas Baker, in his standard work on *The Laws Relating to Burials* (Maxwell & Son, 1873), remarks, on page 304 of the fourth edition:—'In some of the more recently erected cemetery-chapels an arrangement has been made which might serve some of the purposes of places for the temporary reception of the dead before burial as well as their chief object, that of protecting the mourners attending the funeral services from annoying or dangerous emanations from the dead. In these chapels a portion has been divided off from the main building by a glass screen, which completely separates the part in which the coffins are placed from that occupied by the mourners, and it is easy to make this separated portion large enough to hold several coffins, where they might remain without danger until preparation is made for the funeral.'

Drury Lane mortuary, like a great many others in the Metropolis, has been built on an old disused burial ground; and certainly these spaces, occurring as they do in crowded localities, afford a very convenient site for mortuaries, a site, too, which the ordinary prejudices of people against the establishment of receptacles for the dead in their midst can hardly reach.

Wherever possible a mortuary should be screened from the road by trees or shrubs, and should be approached by a winding path also planted with shrubs.

The *internal arrangements and fittings* are most important. There should be ample means of ventilation provided for every part of the building; and the mortuary, though not made too bright by window space, should not be gloomy or depressing in appearance.

Though, of course, a mortuary proper would consist merely of a dead-house, it is very desirable, and indeed essential, that connected with it should be a *room for post-mortem examinations*, and another for the holding of *coroners' inquests.* For it must be remembered that a certain, and in some cases not inconsiderable, portion of the bodies brought into a mortuary will be for identification and legal inquiry—as of persons found drowned, or dead in the streets, murders, suspected suicides, unknown strangers at hotels, &c., &c., and suitable provision must therefore be made not only for a skilled medical examination of the body to discover the cause of death, but also for the coroner and jury to hold inquests on the bodies.

The most objectionable and undignified custom of holding inquests at inns and taverns,—not unfrequently amidst the noise and bustle of business in a low neighbourhood,—hardly needs condemnation at my hands. It has been satirised by several of our great writers, foremost amongst them being Dickens, whose vivid word-picture of the coroner's inquest in 'Bleak House' is doubtless familiar to you all. If all mortuaries had a room fitted up as a coroner's court, the present indecency of inquests might to a large extent be done away with.

The *size* of the mortuary room proper must, of course, be large, and will depend upon the population of the district for which it is to serve. Space for some twelve bodies has been held by Dr. Hardwicke, the able and energetic coroner for Central Middlesex, to be quite sufficient for a large town. The bodies may be placed in shells or coffins resting either upon tables covered with zinc or other impermeable material, or upon trestles, or upon moveable iron brackets fixed round the walls. At some of the London hospitals, catacombs the size of the coffin, and made of slate or brickwork, are used; and for certain purposes these may be found useful.[1] Since some of the bodies are certain to be brought in an advanced stage of decomposition, a stock of charcoal and disinfectants should be kept. Any good disinfectant may be employed, but as the chlorides act most powerfully in preventing decomposition, it would, perhaps, be preferable

[1] In certain cities of the Continent there are mortuary chambers in the form of separate cells completely isolated, in which it is contemplated that families can mourn and watch their dead until the time comes for interment. These, as being wholly religious structures, I do not propose to deal with.

to use them. If carbolic acid be employed, a strong solution must be used. If the dead are in an advanced state of decomposition before they are received, they should be surrounded with sawdust and carbolic acid powder before being screwed down, to prevent annoyance and injury to health. Cloths for covering the dead, which should be frequently saturated with disinfectants, should be provided.

It is important that the mortuary should have in readiness some *shells or coffins* for the holding of corpses whilst a proper coffin is being prepared. It has been suggested that the person desiring to make use of the mortuary should provide these: but experience teaches—as indeed was to be expected—that it is far preferable for the managers of mortuaries themselves to have on hand a few such shells, which can be sent from the mortuary to the place from which the body has to be removed. The Islington Vestry, having experienced difficulties in the use of their admirable mortuary with regard to this question of shells, ordered some of different sizes, made of wood and lined with tinned copper, to be kept at the mortuary for use when required. These are cleansed by the mortuary keeper after each occasion of use. A good rule at this mortuary is that no wooden shells may be removed therefrom except when used to bury in. If a body be transferred from it to a coffin for burial, the shell is sprinkled with disinfectants, split up and burned. At Clerkenwell, the City, and Drury Lane mortuaries, there are also shells belonging to the authorities in readiness for similar emergencies. At every mortuary there ought to be at least one or two air-tight coffins with glass lids for convenience of viewing the bodies on which inquests are held—an oftentimes very distressing and disgusting ceremony for the jurors. Or a well-made movable case with glass on the top might be provided for placing over bodies on which inquests are to be held. The glass should be fixed in a frame hung on hinges, so as to admit of the free use of disinfectants after the case has been placed over the body.

The *post-mortem room* may adjoin, but should be quite distinct from, the mortuary. This separation is needful in order to comply with the terms of section 143 of the Public Health Act, which, whilst giving powers for the erection of post-mortem rooms, distinctly requires that they must be provided 'other than at a workhouse or a mortuary.' Mr. Lumley, in his comments upon this section, observes that 'This exception deserves special attention. It is desired that places should be provided for the removal of dead bodies from the rooms of poor people when they die, and it would create a repugnance on the part of the relatives to such removal in many cases, if a suspicion arose that such bodies might be subject to anatomical examination.[1] This, no doubt, is the feeling which has prompted the legislature to make so positive a prohibition. It is only necessary, however, to take care that the post-mortem room is distinct from the mortuary (*i.e.* that it is walled off from it, has a separate entrance, and is cut off from it in other ways), to comply with the Act of Parliament.

[1] *The Public Health Act*, 1875, *Annotated.* By W. G. Lumley, LL.M., Q.C. (Shaw & Sons, 1876), p. 115.

As to the fittings of the post-mortem room, I cannot do better than quote from a paper on the subject of mortuaries which was read before this Institute at its Stafford meeting in 1878, by Dr. Hardwicke, whose very large experience gives to his utterances peculiar value. Dr. Hardwicke recommends that 'the post-mortem room should be used only for the uncoffined or unclaimed bodies awaiting identification, and ought to be kept cool in summer by a supply of cold water; the corpse having sometimes to be preserved as long a time as possible from decomposition. This room should be furnished with special appliances necessary for post-mortem examinations; a marble or slate slab, with sides sloping towards the centre, converging into a drain below, so that fluids may not run over the edges; a sink with a plentiful supply of cold water; an iron bowl; a coarse sponge; a jack towel; a wooden yard measure; and, for the weighing of organs and structures, a set of weights and scales; a slated footboard around the slate table, on which medical men making post-mortem examinations may stand free from the damp or cold floor. Gas should be laid on, so as to procure warm water, or as it may be found necessary to make the examination at night, or when the darkness of winter days may obscure the view of the subject.'

A great deal of the success of a mortuary depends upon the efficiency of its *keeper*. The appointment of such an officer is absolutely necessary if scandal is to be avoided; but as to the amount of work to be required of him, everything must depend on the circumstances of the case. In mortuaries at cemeteries, the cemetery-keeper may properly supervise the mortuary; in mortuaries at hospitals, the porter or gardener: but as to mortuaries standing by themselves, no rule can be laid down. The duties, however, of the keeper have been thus defined by Dr. Hardwicke in the paper already quoted :—

'His duties would be to receive under his charge not only bodies brought in by relatives and friends of the deceased, but those found dead by the police, or from accidents, or cases sent to the mortuary by the coroner's officer to await an inquest, or by the medical officer or sanitary inspector of the district, in order to relieve an overcrowded dwelling of a corpse dying from an infectious disease, or in a state of dangerous decomposition. He must act under fixed rules, and become responsible for the safe custody of these bodies and such articles of clothing as may accompany them. He must attend to the proper cleansing, disinfecting, and ventilation of the rooms generally, but especially of that used for *post-mortem* examinations and the room used for the reception of a corpse dead from an infectious disease. He must render some assistance to medical men who are called to make post-mortem examinations, in the placing of the corpse in and out of the shell; and his attendance is required upon persons visiting either for the purpose of identification or seeking information relative thereto. It is of the utmost importance that a mortuary keeper should live very near the mortuary, so that he may always be ready at all times to receive bodies. He should also keep a register of the mortuary, containing the date, name, sex, age, address, and other circumstances appertaining to the bodies to be removed;

such as by whom, where to, or to what cemetery, or by what undertaker.[1]

The next point to consider is the *regulation of mortuaries*. As to this it seems to be generally agreed that the fewer regulations there are the better. Restrictions or forms of recommendation only tend to lessen the usefulness of mortuaries, and the best plan is to throw them open to every one who chooses to send a corpse thither. Dr. Letheby, in 1871, drew up an elaborate set of rules for the City Mortuary, but practically these have now fallen into complete desuetude. The subjoined rules, which are in force at the mortuary provided by the Islington Vestry in the Chapel of Ease grounds, Holloway Road, will be found to contain all that is essential in the matter:—

'The dead body shall be enclosed in a proper shell or coffin, such being the shell or coffin in which the body is to be buried, and shall be conveyed to the mortuary chamber, and also removed therefrom in a hearse, or otherwise in a decent and proper manner, and the undertaker or friend shall remove the dead body for interment within an ordinary specified time.

'In case the undertaker or friend fail to remove the dead body within the time specified, notice shall be given to the relieving officer of the parish to bury such body at the expense of the poor rate, such expense being subsequently recoverable from the parties legally responsible.

'A body having been brought or sent by any person whatsoever to the mortuary in a shell or coffin, such shell or coffin shall, under no circumstances, be removed other than for the burial of the body contained therein, unless such shell or coffin with the lid be properly lined with tinned copper.

'Should any shell or coffin sent with a body prove to be in a defective condition, a thoroughly sound and larger shell must upon notice be supplied, in which the defective shell can be enclosed, or in default the sanitary superintendent shall order a proper shell to be provided, and the expense will be recovered from the party sending such defective coffin.'

As to the *reception of cases*, there is a useful rule at the mortuary at Dean Street, Soho (which is under the control of the Burial Board of St. Anne, Westminster), empowering the attendant to receive a body without an order (otherwise necessary from a member of the Burial Board), if it be accompanied by a policeman or known inhabitant. At the mortuary in Drury Lane, which was established some years ago by Lady Burdett Coutts, Lord Vernon, and other benevolent persons, on the disused burial ground of the parish of St. Martin-in-the-Fields, there is a rule forbidding the admission of any public procession or large assemblage of persons into the grounds on the occasion of the admission or removal of the body. Only the immediate relatives, the undertakers, and bearers are allowed on the premises,—a commendable rule, which deserves imitation.

[1] The scheme of duties for the keeper drawn up in 1871 by the late Dr. Letheby for the City Mortuary, or the Islington rules based upon it, may be recommended for general adoption.

At this last mortuary bodies are received from 8 A.M. to 8 P.M from September 1 to April 30, and from 8 A.M. to 10 P.M. from May 1 to August 31. Practically it would be found best to impose no limitation on the *hours when bodies are to be received*, as it may often happen, especially during epidemic periods, that it is essential that the body of a person dead of infectious disease should be removed instantly. It might be well, however, to have a general understanding on the subject, as at the City Mortuary, where all bodies are systematically removed by 11 P.M., though there are no specified hours named.

No *charge* should be levied on the relatives of the persons whose bodies are deposited in the mortuary, as it is very important to encourage its use as much as possible. At none of the mortuaries of which I have information is such a charge made. The expenses of inquests held at the mortuary would of course be paid by the coroner.

The *visits of friends and relatives* need a word of mention. In most of the mortuaries that I am acquainted with there is no limitation to the unrestricted visits of friends within reasonable hours. At the Drury Lane mortuary the number of persons is restricted to three, between the hours of nine in the morning and sunset; and at Hackney, where two mortuary chambers (one for accidents and non-infectious diseases, and the other for infectious cases) have been provided, no one is allowed in the infectious disease chamber. At this mortuary infectious corpses are wrapped up in a sheet soaked with carbolic acid and water, and are placed in a shell when they arrive, if they are not brought in one. They are then transferred, as soon as possible, to a coffin in which sawdust and carbolic acid have been put, and the coffin is screwed down.

This leads me to the question whether or not it is necessary in providing mortuaries to have a *separate chamber for infectious cases*. I do not think that this separation will usually be found necessary, though, of course, there is an additional precaution when it is done. All infectious corpses ought certainly to be dealt with as at Hackney, and should be screwed down as soon as possible, a piece of glass being let into the lid of the coffin in cases where it may be considered expedient or may be desired by the relatives. The question whether it should not be compulsory, without the necessity and uncertainty of applying to a justice, to send infectious corpses to mortuaries from houses where proper isolation cannot be observed, is one upon which I can hardly express a decided opinion. It appears to me, however, to be eminently desirable from a sanitary point of view, and to offer hope of helping to diminish our yearly death-roll from preventable disease.

The public ought to have *easy access* to mortuaries, and every reasonable facility should be offered them for so doing. In those cases in which the body of a person is found drowned, or is unknown or in other ways undistinguishable, provision should be made so that all the clothes of the deceased may be exposed to view. At present it is by no means easy for people who desire to view the bodies of unknown persons to accomplish their desire; and the natural consequence is that they come not to care to do so. The number of persons annually consigned to mother earth whose names and stations in life are utterly unknown is very large; and it cannot be doubted that if more easy means of identification were provided, as by the exhibition of their clothes, we might reduce the number to an appreciable extent. Moreover, in this manner foul play might more readily be detected, and mysterious disappearances cleared up. When it is borne in mind that of the three or four hundred persons annually exposed at the Morgue in Paris, half the identifications are due to chance; and that since greater facilities for the entry of the public to that institution have been made, the identifications have increased from barely three in every four bodies to nearly eight in nine, and that the police have been greatly assisted in the detection of crime, the importance of reasonably free access to a public mortuary will be recognised. I must guard myself against being supposed to advocate the setting up in England of an institution like the Morgue, for the sensational sights exposed to public view in that building are clearly very undesirable. It is, nevertheless, of great importance to allow such free access as may help to assist in clearing up a mystery or may lead to the detection of a crime. Of course, the gratification of mere morbid curiosity must be strongly disencouraged, but it would not be at all difficult to do this with proper regulations. Many of the identifications at the Morgue, which is the most complete institution of its kind extant, are made through the clothes of the deceased being conspicuously exposed; and the importance of preserving all articles of dress worn by an unrecognised corpse must therefore be strongly insisted on. At the Morgue a special room is provided for the retention of clothes of the unrecognised dead for from six to eight months after burial; but the number of deaths of persons unknown is likely to be so small at ordinary mortuaries that a box or press would be quite sufficient for the purpose.

I should wish, in conclusion, to say a few words as to the *burial arrangements* to be made by the managers of mortuaries. The length of time that should elapse between the reception of the body and the burial is of some importance; and it will be observed that the justice's order referred to in section 142 of the Public Health Act may direct a body 'to be buried within a time to be limited in such order.' It becomes, therefore, of moment to know what should be the maximum time allowed. In England we have no power of requiring burial within a fixed period from death, though it is eminently desirable that we should have this power. It may not, perhaps, be generally known that in a Bill of 1842 there was a clause which proposed to provide that 'from and after the first day of October, one thousand eight hundred and forty ——, if any dead body shall continue unburied between the first day of May and the thirty-first day of October, both days inclusive, more than —— hours, or between the first day of November and the thirtieth day of April, both days inclusive, more than —— hours, the executors or administrators to the estate and effects of such deceased person, or the friends or relatives of the same, or any one of such friends or relatives present at the burial, or the occupier of the house from which such dead body shall be removed to be buried, shall forfeit the sum of twenty shillings for every twenty-four hours after the expiration of such respective periods.'

Nothing, however, came of this, and I do not think the question has again been raised. On the Continent, however, and in America, the state of affairs is different. Thus the New York Board of Health, whose sanitary regulations are extremely full and careful, have ordered that 'no person shall retain, or allow to be retained unburied, the dead body of any human being for a longer time than four days after the death of such person, without a permit from the department, which permit shall specify the length of time during which such body may be retained unburied.' It would seem, therefore, wise to take this standard, and make regulations to the effect that a body must be removed from the mortuary within four days of the death. At Drury Lane every corpse must be removed for interment within six days from the date on which the death occurred. Corpses of persons dead of cholera must, however, be removed within two days, and those dead of other dangerous infectious diseases within three days, power being reserved to the Medical Officer of Health to order the interment of a rapidly decomposing corpse at any time.

As to the actual *arrangements for interments*, not much needs to be said. The portion of the Act dealing with this matter is not particularly clear, but Mr. Lumley, in his comments upon it, seems to think that the interment of bodies from a mortuary should, when necessary, be performed by the Sanitary Authority. In practice, however, burials from a mortuary that are not paid for by the relatives are performed by the Poor Law Authority, *i.e.* the Guardians. So far as I know, no legal question has yet arisen as to the interpretation of this clause; and probably it would be better not to disturb the existing arrangements.

In thus endeavouring to give consideration to the subject of mortuaries in its various aspects, I fear I have been unduly prolix; but as no one else has yet grappled with the question in the fashion that I have attempted to do, I have thought it desirable to place on record the facts that I have been able to gather together on this important subject, in the hope that they may be of assistance to those who are striving to provide for the establishment of mortuaries in their midst. I am convinced that there is no subject more worthy of the attention of the clergyman, the philanthropist, and the sanitarian than that upon which your indulgence has permitted me thus to descant.

HENRY C. BURDETT.

APPENDIX.

LIST OF MORTUARIES.

A. METROPOLIS.

In 1875 the *British Medical Journal* took measures for ascertaining the actual amount of mortuary accommodation existing in the Metropolis (see the No. for December 25, 1875, page 802). Since then certain other mortuaries have been constructed, but extensive districts in London are still without such a building. Of the following the author has particulars:—

BATTERSEA.—A mortuary 'projected,' for six bodies, with post-mortem room (A.D. 1875).

Bermondsey.—Mortuary, with a post-mortem room.

Bethnal Green.—A handsome mortuary chapel was opened in June 1880 in the disused churchyard of St. Matthew's, Bethnal Green. It was built at a total cost, including the excavation of the site and the removing and re-interring the bodies, of 1,522*l.* The building contains two mortuary chambers, one for ordinary uses and the other for the reception of infectious cases. Each chamber is 16 feet square, and the height from the floor to the apex of the roof is 23½ feet. The two chambers provide accommodation for forty bodies. The material used is brick, with dressings of Portland stone; the floors are finished with patent Victoria stone. The whole of the exposed woodwork in the interior of the building is of pitch pine stained and varnished; the interior walls are finished with Keene's cement and painted. The shelves in the mortuary chambers are of thick slate slabs carried on iron cantilevers, and great care has been taken throughout to keep everything as flat as possible, and to avoid ledges and projecting mouldings, so as to prevent lodgment of dust and dirt, and so that the whole of the interior can be thoroughly cleansed without difficulty. The post-mortem table is constructed of wood, with a leaden top, so arranged as to drain towards the centre. In one corner of the post-mortem room is a large sink with water supply, and a hose-pipe is provided, so that everything can be washed down without delay or inconvenience; the room also contains a large gas-heated boiler, so arranged that hot water can be obtained in a few minutes, and gas is laid on throughout the whole building.—*British Medical Journal,* vol. ii., 1880, page 517.

City of London.—Mortuary provided in 1871, by Commissioners of Sewers, from plans by Colonel Haywood, C.E. Buildings include (1) mortuary chapel, with 12 slate tables; (2) keeper's house and office; (3) coroner's court, &c.; (4) laboratory; (5) weighing-room; (6) consulting room; (7) dead room, fitted up for post-mortem examinations; (8) disinfecting apparatus, &c.; (9) ambulance shed; (10) shed for disinfected clothing. The buildings were erected in Golden Lane at a cost of 12,000*l.*

Clerkenwell.—Mortuary at Spa Fields Burial Ground, including coroner's court, post-mortem room, disinfecting oven, and all necessary appliances. Cost 2,500*l.*

Fulham.—A mortuary at Fulham Cemetery. Another at workhouse, which District Board has permission to use.

Hackney.—Two rooms—one for the reception of accident cases, the other for infectious cases. Floor of the latter of stone, and kept watered with solution of carbolic acid.

Hampstead.—Mortuary belonging to Burial Board at Fortune Green Cemetery. The medical officer of health has expressed his regret that 'it is not more used and better valued.'

Holborn.—Mortuary 'in construction' for 12 bodies in 1875.

Islington.—Mortuary in Chapel of Ease grounds, Holloway Road, with coroner's court, two waiting rooms, a post-mortem room provided with water, and two mortuaries—one for infectious cases. Reported to be very useful.

Kensington.—Plans prepared by architect of Vestry, and agreement made with churchwardens settling the conditions on which a mortuary may be erected in the disused parish churchyard.

Lambeth.—Mortuary for 12 bodies, with post-mortem room.

Lewisham.—A small building with lean-to roof, to hold 4 or 5 bodies. Has a post-mortem room.

Marylebone.—Mortuary and post-mortem room; but nearly two miles apart. No coroner's court.

Mile End Old Town.—Mortuary, 'replete with improvements.'

Poplar.—Mortuary for 40 bodies. No post-mortem room.

St. Anne's, Westminster.—Mortuary established at Dean Street, Soho, under the control of the Burial Board of St. Anne's, Westminster. The first of its kind in London. Under the superintendence of a resident attendant. It adjoins the parish church. Friends of a deceased person can at all times have access thereto, and a separate room is provided for mourners to assemble in on the day of burial. No fee or charge whatever allowed.

St. James's, Piccadilly.—Mortuary at Dufour's Place, Broad Street, Golden Square.

St. Luke's.—Accommodation building (1875) for 12 bodies.

St. Mary, Newington.—A railway arch adapted for purpose; also post-mortem room.

St. Saviour's.—For 3 bodies; also post-mortem room.

Shoreditch.—A mortuary on ground adjoining the church. Glass coffins for recognition of unknown dead, disinfecting apparatus, and suitable means and conveniences for conducting post-mortem examinations.

Strand Board of Works.—Mortuary in Drury Lane, provided by private benevolence on the old disused burial ground of St. Martin's-in-the-Fields. Well constructed and very useful.

Tottenham.—The Medical Officer of Health chronicles in his annual Report for 1879 the decision of the Local Board to establish a mortuary.

B. Provinces.

Birmingham.—Five mortuaries, the last opened recently. All in connection with police stations. Bodies received are mostly those of persons who have come to a sudden or violent death. In 1879, 79 bodies were received.

Bristol.—A mortuary chamber at the cemetery.

Darlington.—A mortuary in the corner of the site of the Fever Hospital, fitted up so as to serve also as a post-mortem room.

Derby.—Mortuary erected in 1879. Inquest cases only have, up to the present, been received.

Dublin.—'Until the year 1871, the only provision for receiving remains awaiting inquests, or for making post-mortem examinations, was a shed connected with a dairy yard. The means for removing such remains for interment were equally defective and discreditable, and in 1871 the Public Health Committee undertook the erection of a morgue, mortuary-house, and coroner's court, which, at a cost of about 1,200*l.*, were completed in 1872. The number of remains annually deposited in the morgue has averaged 93. In the accommodation afforded by this establishment, and in the arrangements made for giving effect to its objects, it is considered to be inferior to no other in the Kingdom.'—*Evidence of Mr. James Boyle, before the Dublin Royal Sanitary Commission*, Q. 3708.

Exeter.—Mortuary at cemetery.

Gateshead.—Provision of mortuary and post-mortem examination resolved upon (1879).

Liverpool.—In his annual report for 1879, Dr. Stopford Taylor states that 'During the year, 66 bodies were, by order of the justices on the certificate of the medical officer, removed to the mortuaries provided by the council under section 142 of the Public Health Act.'

Manchester.—A mortuary chamber in the interior of the town for special cases of infectious diseases.

Newcastle-on-Tyne.—There is a mortuary here, but it is evidently not used as it ought to be. The Medical Officer of Health, in his report for 1879, says that during that year nine bodies were removed to the mortuary by the sanitary authority on account of relieving officers declining to give orders for interment unless this were previously done. There appears to be considerable irregularity in the method of procedure adopted, most of the bodies thus dealt with have been such as did not strictly come within the meaning of Section 142 of the Public Health Act. The bodies seem to have been removed solely to prevent the poor-law authority from being imposed upon.

Salford.—A 'commodious mortuary, with charcoal ventilators and every modern improvement,' has been provided within the enclosure of the Wilton Fever Hospital. The Medical Officer of Health reports that 'the building is a large one, and its ventilating and disinfecting arrangements are such as to allow of a corpse being retained in it for a reasonable time, without giving rise to perceptible nuisance.' He adds: 'The building will be available for post-mortem examinations by order of the coroner or otherwise, and the conveniences which exist in connection with the mortuary will very considerably conduce to the comfort of those who have to make the autopsies.'

Scarborough.—Two mortuaries, one constructed by the Corporation on their own premises, the other at the cemetery. The first is substantially built of brick, and is fitted up for post-mortem examinations. It is used for the reception of the drowned, and of tramps dying in common lodging-houses. The second is intended for the reception of coffins pending interment, and has been found very useful.

Sidmouth.—A receiving-house has been erected in connection with one of the chapels of the new cemetery, in readiness for the immediate reception of bodies until burial, in case of infection or otherwise. The Medical Officer of Health reports that thus far it has not been needed.

Sunderland.—The health officer, Dr. Yeld, says, in his annual report for 1879, 'The mortuaries [? number] belonging to the Corporation have been carefully attended to, and during the year a supply of water has been laid on to each. With one exception, all the bodies removed to these buildings were those of persons found drowned, or who had met with a violent or sudden death. Dead bodies arriving at the port on board ship are removed to the Sunderland Mortuary at the foot of Coronation Street.' There is also a mortuary at the Fever Hospital.

Wigan.—A mortuary constructed about the year 1878 in the grounds of the Infectious Hospital, and intended for the purposes of the general population. Much difficulty experienced in inducing poor people to make use of it.

C. Abroad.

Amsterdam.—Infectious corpses are placed in two special chambers reserved in the mortuary.

Berlin.—A mortuary with two common rooms and a dissecting-room. Mortuaries stated also to exist in the greater number of the cemeteries.

Bremen.—A common room for the deposit of corpses, a dissecting-room, a laboratory, and an anatomical museum.

Breslau.—Mortuary chambers in certain cemeteries. An endeavour is being made to establish others.

Brussels.—A mortuary will shortly be erected (if not already finished), specially with a view to the reception of corpses without proper accommodation at home. The mortuary, which will be a part of the Church of St. Katherine, consists of a large hall or room, in which will be built a number of compartments separated by half-partitions, cut at their lower part to allow the air to circulate top and bottom. Orifices for the entry of the exterior air will be made in the lower part of the walls, and the vitiated air will escape by a chimney placed in the middle of the vault of the room, and provided with a crown of gas jets.

Carlsruhe.—A building in the new cemetery, which is both a mortuary and an anatomical institute. There is a common room, and separate cells for particular corpses.

Cologne.—A mortuary for the reception of bodies of persons dying in crowded homes. The superintendent is the keeper of the cemetery, who goes from time to time into the rooms to observe the changes in the bodies. At the end of seventy-two hours the coffins are closed and taken away.

Dusseldorf.—A mortuary containing a vaulted room underground, in which are placed those corpses whose death is incontestable. It serves also especially in times of epidemic. On the ground floor there are a mortuary chamber and a post-mortem room.

Frankfort.—A mortuary consisting of ten cells, ranged round a room in which is a watchman.

Geneva.—One room in the Morgue is reserved as a mortuary chamber. Those corpses which have not been interred in one of the parishes of the canton, within the time fixed by law, and the burial of which is delayed, must be taken to this mortuary. A tax of five francs a day, for the first ten days, is imposed for the deposit of the corpse. The corpses thus deposited must be placed in a lead coffin and a coffin of strong oak.

Gratz.—Reception room at each cemetery.

Hamburg.—Two mortuary chambers.

Lemberg.—Mortuary chambers in each hospital and in each cemetery.

Milan.—Mortuary chambers in the new cemetery.

Munich.—By the terms of a police ordinance dated July 1, 1862, corpses must be taken to the mortuary within twelve hours after death, or, when disease is epidemic, within six hours. The departures from this rule are stated to be quite exceptional. The transfer of the corpse to the mortuary is made in a special carriage. In each quarter, a woman appointed by the municipality is charged with the shrouding of the body.

Naples.—Two mortuary chambers, one a reception room, the other for post-mortem examinations.

New York.—Public Morgue at the Belle Vue Hospital.

Paris.—Although there is here the well known Morgue (which is about to be replaced by a new one), there is no public mortuary in the ordinary sense of the word.

Prague.—Mortuary chambers in nearly all the parish churches, and in all the hospitals.

Rome.—Mortuaries in each parish: used when circumstances compel a prompt removal of the body.

St. Petersburg.—A mortuary is about to be erected in the old cemetery.

Stuttgart.—A mortuary in the central cemetery. Two large rooms on the ground floor, two on the first floor, a special room for particular corpses, and a dissecting room with its accessories.

Ulm.—A mortuary containing (1) an underground common room in which are placed the corpses of those who have succumbed to infectious diseases; and (2) a common room on the ground floor for the deposit of corpses, a certain number of cells for the reception of a corpse by itself when the family desires, and a dissecting-room.

Venice.—A mortuary in course of erection.

Vienna.—At Vienna there is a mortuary, the 'Todten Kammern,' where the unknown dead are exposed for identification. It consists of a number of long bare rooms, with the windows placed high up in the walls. Arranged round each chamber are a number of sloping couches upon which a strong light is thrown from reflectors placed in the ceiling.

Weimar.—A mortuary situated to the north of the cemetery, arranged both for the deposit of corpses and as a post-mortem room.

Mr. WOODMAN had remarked, during the reading of the paper, the omission of Exeter from the list of places in which mortuaries were provided. Exeter had a mortuary at the Cemetery, open to use without charge, and he could speak most highly of the way in which it was conducted. The more they could induce people to bury early, or at least to remove the dead from the homes, the better. He instanced deaths which had resulted from people kissing the bodies of their deceased friends.

Mr. CHADWICK said it was timely that this subject should be brought forward. It would require great delicacy and skill, speaking of the metropolis, in carrying out. His conclusion, after investigating the subject some time ago, was that doing the thing well and improperly depended upon the means, and that the subject should be left alone unless there were the means. In some Continental States a body must be interred within twenty-four hours, but no body could be interred unless a medical officer had testified to the death and the cause of death. The mode required great skill in its accomplishment, but as to the necessity there could be no question. The horrors and dangers of keeping the dead body among the living evidenced the barbarism in which we were still, and the low state of civilisation, which did not regard those conditions and did not go into them. The provision of the mortuary system would require a great deal of administrative skill in the officers and in the provision of the appliances.

Mr. BURDETT requested that those who had information concerning mortuaries not mentioned in the paper should send it to him, addressed to Greenwich Hospital.

Dr. CARPENTER said that Mr. Burdett had made no reference to cremation.

Mr. WOODMAN remarked that the great objection to cremation was the difficulty of preventing murder and the possible prevention of the detection of crime, such as that of Palmer, the Rugeley poisoner. Burial poisoned the ground, but cremation purified.

Mr. CHADWICK said that the papers once, the *Spectator* in particular, accused him of having advocated cremation. The fact was that not only he, but the first General Board of Health, carefully examined the question, and it was his belief that interment with economy—that was, that the earth burials should be without placing large numbers of bodies in one grave—was better than cremation. The evidence had not been altered, and he adhered to his opinion.

Mr. BURDETT explained that he had not referred to cremation because he had strong objections to it, added to which there were religious and other objections; moreover, Mr. Cross had said that in his opinion cremation was illegal, and if it were not he would very soon make it so.

Abattoirs.

In 1848 I published a treatise 'On Slaughterhouses considered in connection with the Sanitary Question.' It will be remembered that about that time a Committee was formed to assist the Government in introducing legislation for the establishment of a sanitary system for the management and control of all questions relating to the removal of refuse to a distance from the midst of populations, so that it should not be retained or allowed to increase proportionately with the population. The system was also intended to comprehend regulation of all necessary powers connected with sanitary matters.

The result of the investigation was that the Public Health Act (1848) was introduced into Parliament and passed. Being a member of the Committee above referred to, I took up the branch of the question relating to slaughterhouses, and was induced to publish my treatise.

I may repeat the quotation from Shakespere, which appears on the title-page—

> Away with me all you whose souls abhor
> The uncleanly savour of a slaughterhouse,
> For I am stifled with the smell.

In order to fully understand the subject I visited Paris, where, it may be recollected, five large abattoirs had been built about the year 1809, under decrees and by the authority of the first Napoleon. I procured the plans from which these buildings were erected at Paris, as well as those in other cities on the Continent, and of the very few that had been established by private individuals and corporations of towns in this country. None of the latter, however, were under municipal control, and consequently they only concentrated the evils of the system of slaughterhouses, and were for the most part undertaken and managed as a matter of private remuneration.

My attention was not merely directed to the structural arrangements and design of the buildings, but also to the laws, rules, and regulations for the conduct of the whole system. I may here state that, considering the period at which the buildings at Paris were erected, and at which the regulations for their management were drawn up, it shows a remarkable foresight and consideration for the necessities and health of Paris, and for the future increase of the population.

A detailed description of the five buildings, their situation with regard to localities, the system of taking the animals by certain routes from the markets to the abattoirs, and the distribution of meat to different parts of Paris, would probably be interesting, but would not very much assist or promote the questions which the Institute aims at.

I read a paper at the Institution of Civil Engineers in 1849 (vol. viii. p. 66 of its 'Transactions') which refers to the buildings, and not only gives a full description of all regulations of the management of the abattoirs, but the statistics of the trade of the butchers and markets and the control exercised by the municipality of Paris over the trade.

The Paris abattoirs have of late years been removed from Paris in consequence of the crowded state of the city and the increasing value of property, and have been erected in the suburbs, but I have not seen them, nor do I know in what manner they are governed.

I should say that there was a large income derived from the original abattoirs.

I have had occasion to suggest modes of management of public slaughterhouses. It is obvious that they should be adjacent to cattle markets.

I should deprecate their being under the management of private persons, because I think they should always be under the control of the local authority both in constructing and laying out the buildings, and in the removal and disposal of the offal and filth.

There is no doubt but that if the offal and manure were dealt with by the authority and the most made of the products, a fair remuneration might be obtained, and that the butchers should have an equivalent for these products being taken.

The melting of tallow could be carried on within the precincts of the abattoir, also the preparing hides for tanning, manufacturing catgut and glue, and treating blood for some purposes, treating bones, making Prussian blue, and several other processes.

By such means and by letting portions of the buildings for slaughtering, as well as by storing meat in proper places, the Paris abattoirs made a good return, although their expenses for inspection and men were very considerable.

It need scarcely be said how many nuisances from unpleasant and injurious effluvia among populations would be removed not only out of sight but out of smell if abattoirs were established.

Other material benefits are obtained under the combined system which abattoirs afford in the killing and dressing meat, and in the inspection of unwholesome meat which can be at once detected and destroyed.

I know that abattoirs have been erected in several towns in England, and the Local Government Board have recently issued model bye-laws both for the control of markets and abattoirs, and have laid down stringent rules for the use of sanitary authorities. But from the first, when my attention was called to this branch of sanitary government, I felt that the slaughtering of animals should be compulsorily carried out in one or more spots according to the size or population of the town, and that the buildings should be erected and managed in very large populations under the superintendence of the local authorities. I am aware that should this be carried out it would interfere with the business of private persons, but in time that might be got over.

R. B. Grantham.

Mr. Chadwick said that the General Board of Health also examined this subject, but found that to give full effect to the utilisation there must be a centralisation of the abattoirs, so that while the prevention of disease was attained the products of the place were collected on the spot for utilisation. Scotland was sending meat to the Metropolitan market, and the manurial products, &c., were utilised at the place of production. Then there was also to be considered the importation of meat from abroad. The importation of disease in cattle had its origin in the same way as the importation of disease among human beings, by the massing of cattle unhealthily together. It was necessary to prohibit the slaughtering of cattle in small and improper places.

Mr. Rawlinson said that in this country we were not sufficiently aware of the fearful results of private slaughtering. If all the cattle were slaughtered in properly-constituted slaughter-houses, there would be no chance of a great deal of the diseased meat being consumed. Not long ago he was sent over to Dublin at the head of a Royal Commission, and found that in Dublin there was not a single public slaughter-house. He and his colleague recommended that public slaughter-houses should be built, and the private slaughter-houses closed. But he deprecated the massing of slaughter-houses, and making huge show establishments of them. In Paris the abattoirs covered over 60 acres, and anything so dreadful to the non-professional visitor he could not have conceived. Men and women, engaged in the slaughtering of cattle, were covered with blood from the tips of their toes to the crowns of their heads. After a sight of the way in which calves were used he could not eat veal for a long time, and he promised himself that he would never go again into a large public slaughter-house.

Mr. White asked if the use of the Exeter abattoir was compulsory?

Mr. Rawlinson replied that if a Local Board provided an abattoir, and a private slaughter-house was shown to be a nuisance, the latter would be closed, and the butcher would be obliged to use the abattoir.

Mr. Woodman expressed a hope that the public would only deal with butchers who slaughtered at the abattoir, for he was convinced that dead animals were taken into the private slaughter-houses.

Mr. Grantham, in his reply, said that it could not be expected that butchers should remove from their private slaughter-houses unless there were abattoirs provided. Now they had been provided in Exeter the town could close the private slaughter-houses by proceeding against them as nuisances.

It being now past 5 o'clock, an adjournment took place, the President remarking that they had had a very succcessful Section, and he trusted that it would be an earnest of the remainder of the business of the Congress.

SECTION II.

ENGINEERING AND SANITARY CONSTRUCTION

SECTION II.

ENGINEERING AND SANITARY CONSTRUCTION.

The President of the Section, Robert Rawlinson, Esq., C.B., C.E., F.G.S., delivered the following address :—

Sanitary science may be said to be both old and young. It is so old that we know nothing of its commencement, simply because we know nothing definite of the origin of the human race. The cave inhabitants were skilled in art; but at how distant a period they lived, or in what other respects they were skilled, we have little means of knowing; of this, however, we may be certain, that they would suffer from disease and would use medicines and enchantments in some form to relieve their sufferings.[1] At whatever period of this earth's history intelligent man appeared, diseases would afflict him; and when remedial measures were invented and applied, then *sanitary science commenced.*

There are problems in natural history which can only be speculative; as, the origin and constitution of matter; the origin of life; the origin of disease. The human intellect is powerless to fathom these profound mysteries, and if revelation is rejected, there can be nothing but a blank impenetrable darkness. There is minuteness below the search of the best microscope, and a range in magnitude very far beyond the combining power of the best telescope. One law alone is clear and certain, namely, the universal law of motion, which is change —combination and disintegration. These never cease. That which we call life or death pervades the universe; and the life of a system— sun and planets—though extended to millions upon millions of years, is, in the roll of eternity, no more than the life of an emmet, which is born and dies in a summer's day. As old systems perish, new systems replace them, to run their appointed course from birth to maturity, and from maturity to decay. I have neither time nor inclination to attempt to summarise ancient and modern theories as to ultimate atoms, if, or if not, such exist; as, also, if or not, each atom is sen-

[1] There are dwellers in caves at this day in parts of Great Britain and Ireland, as, also, in other parts of the world—probably as many as ever in any age occupied such places for residence.

suous, and that, as a consequence, all bodies have developments of sensuousness in a degree—the combination of atoms in man developing sensuousness in the highest degree. Matter combined in living forms other than animal life develops properties very like consciousness, as plants shrink from poisons, and, with apparent avidity, seek wholesome food, in this respect showing an intelligence superior to many forms of animal life. I, individually, should like to believe that plants can think.

But to the purport of this paper,—'Old Lessons in Sanitary Science Revived, and New Lessons Considered.' The most reliable starting point I will take may be found in Leviticus xiv., beginning at the 33rd verse, where the plague of leprosy is described afflicting the house. Without extracting the whole, the sanitary engineer will recognise 'the walls with hollow strakes, greenish or reddish, which, in sight, are lower than the wall.' Here is vividly described a tainted subsoil, wet and rotten with saturated filth. The modern remedy would be, entire removal of the tainted subsoil, to be replaced by lime concrete, removal of the tainted walls, underpinning with new material, and the introduction of a damp-proof course. Leprosy (or the equivalent of leprosy) affects houses at this day in all parts of the world inhabited by man, from European palaces to the hut of the Esquimaux.[1] In this malarrangement the savage fares better than the civilised man, as nomad tribes can leave a tainted site, whilst dwellers in villages, towns, and cities remain fixed on sites filth-tainted to supersaturation. Seeds of disease ripen in the polluted huts and houses of India, China, and Europe, and the North American cities have not escaped this general contamination. Australia and New Zealand have already polluted the sites of their cities to a dangerous extent, so that the mortality returns are no better than those of the old country.

In England we have apparently banished plague, which, however, prevails in the East—Russia, Egypt, and the cities of Asia; but England has ripened the '*germs*' of cholera very recently, and typhus, typhoid, and other forms of fever commonly prevail. That these diseases can be prevented our model prisons bear witness, and modern sanitary works have also materially improved entire town communities.

I have used the word '*germ*' as applicable to disease, without in the least being enabled to explain satisfactorily what is meant by it. That types of disease can be introduced and spread will be readily admitted; but that the origin, in each case, is a *germ* is not so easy of

[1] It may not be strictly proper to use the word 'leprosy' as being common to houses; the meaning is, that houses are filth-tainted to an extent which causes rottenness capable of producing disease.

proof. It has been suggested that cholera must be conveyed to the human system in water; as, also, that tainted water and tainted milk produce typhoid and scarlet fevers; and some say that fluids are necessary to the introduction of these forms of disease into the human system, periods of time being fixed for incubation. There are, however, some facts against this theory being received in its entirety; as, for instance, troops and travellers on the march into a virgin country previously unoccupied by man, develop these forms of disease much beyond the assigned period of incubation, which, under the surrounding conditions, cannot be due to man-tainted earth, air, or water. So that the germ theory fails, unless we can imagine that germs of every form of disease which can afflict men or animals are as eternal as matter, and are dormant in matter until conditions for development are brought about. According to this idea, soil, water, and air, and every human body must contain germs of every disease, but dormant, until brought into contact with conditions favourable for development.

The cleanest looking places are not necessarily the safest.

A clean looking country house or village, surrounded by pure air free from coal smoke, may have hidden dangers worse than any in a town.

Visible dirt is not always the most dangerous, as the rain washes it, the wind blows over it, and the sun dries it.

The presence of rats, either in country or in town, is a certain indication of danger, as rats live on garbage. They are usually diseased, and can convey the seeds of disease.

It is not possible to predict, in all cases, as to what shall cause disease in excess in any given locality, as filth under peculiar and unknown modifications, or plus an unknown factor, may be sufficient to cause typhoid, without the so-called specific germ from a previous case.

A telluric influence, or an atmospheric influence, which we can neither control nor analyse, in combination with great elemental disturbances, may produce disease in excess.

It is difficult in all cases to prove contagion, and it may be as difficult in other cases to disprove it. In the East woollen garments are believed to be capable of conveying plague; but shoddy, which is waste woollen rags, collected and brought into Yorkshire from all parts, even where plague prevails, when manipulated by hand, never produces plague.

Great epidemics are not universal, but prevail over limited areas, for reasons similar to those which control and limit other excesses in nature. In meteorology excesses are always local, not universal, the areas affected being very much smaller than the areas unaffected.

The surface of the earth, the air, and the water, are modified by the elements, but not at one and the same time over the entire crust and circumference of the globe; but by sections at intervals, as in earthquake shocks, tornadoes, hurricanes, and deluges—these are always local, never universal. The seats of earthquakes change; all known active volcanoes having ruptured the tertiaries. But geology proves that earthquakes and volcanic eruptions disturbed the oldest rocks as now the newest.

Theories may be very harmful when wrongly set up and obstinately persisted in, because they lead the student from the true paths of research. A man with a theory which he is determined to establish, may be likened to a man digging himself into a well; the deeper he digs the less of the surrounding world he sees, but he nevertheless imagines that he is widening the range of his vision. To ascertain truth theories must be suspiciously examined, and facts alone when established be accepted. The world and its phenomena must be studied, and modern means and appliances show us that this is a very small world which we inhabit.

Science has artistically divided our world's history into geological periods, beginning with the lowest and, therefore, presumed to be the oldest semi-crystalline rocks, which at the time of their deposition were mud, and ending with the upper tertiary and alluvium. Ocean, earth, air, climate, and organised life (vegetable and animal) through the deposition of the older strata, are supposed to have been widely different to anything at present existing; but recent research has very much modified these crude notions, and it is now already perceived and proven, as far as proof is practicable, that there have been changes in the solid crust of the earth many times repeated, by land and ocean alternating, but only in such manner as we see at present. Ocean, air, wind, sunshine, frost, and rain, have been working mechanically and chemically in disintegrating the dry land; levelling mountain ranges and continents to fill ocean hollows, and thus again preparing for complete submersion of the old land, and by the heat of compression to bring forth a new birth.

The probability is that mountain ranges and ocean hollows, with continents, seas, islands, and rivers, existed in some such relative proportions as now, during the entire range of the water-deposited rocks, climate being modified by the relative position of ocean and land. Dry land teemed with vegetable and animal forms of life; ocean, seas, lakes, and rivers, swarmed with fish, many various and some strange, so that we must give up the chaos theory, and believe that the creating power through the preceding ages neither slumbered nor slept. These ages are in their entirety but as a lightning flash, a speck, a thought, eternity knowing nothing of time. We have no certain foundations upon which to build the structure of progressive development in geology; as we may say of fossil forms, that only those fitted to endure mechanical and chemical action through unknown ages have remained, and these are for the most part cast impressions and the solid bones and enamelled teeth of reptiles and fishes. Men are apt to draw general conclusions from limited periods and contracted areas. We assume history in periods, as for instance from the heptarchy to Queen Victoria, in a manner to lead a student to believe that the manners and customs of two thousand years ago have entirely passed away from the earth, when we may at this day travel into every phase of civilisation, and see every form of dwelling, from hut and tent of the nomad to cities such as London and Paris. So that a student, in place of relying entirely upon closet study, may, by travel, see man under almost every aspect known to research or described in history.

A closet study of history is however advisable, if only to learn how much error has prevailed and prevails; and it is to be hoped that study will modify egotism. Catalogues of huge convulsions, such as earthquakes, tornadoes, frosts, droughts, and floods, of plagues, famines, and pestilences, have been compiled which seemed to the affrighted inhabitants of the time so terrible and fatal, that they thought the entire family of man must perish from the face of the earth. Exceptional seasons, hot or cold, wet or dry, long continued, affected vegetation, then animals, then man; we witness this course of events in our own day, both at home and abroad. Exceptional seasons lead to famines, disease, and death. Here again we have not to go to history to learn the deadly records of famine and plague, as at this very time the freshly written records are before us :—famine in India, in China, in Asia, and in Ireland. If England can say that since 1665 plague has disappeared, typhus and typhoid fever remain.

The history of the great plague in London, 1665, is to be found recorded by Nathan Hodges, M.D., and John Quincey, M.D., and by an anonymous author in 'a collection of very valuable and scarce pieces relating to the last plague in the year 1665, and reflections on the weekly bills of mortality so far as they relate to all the plagues which happened in London from the year 1592 to the great plague in 1665, and in Naples 1656, of which there died in one day 20,000 persons.' There are other histories of the great plague of London, the picture by Defoe being considered more reliable than the histories. Plague raged about this time, not only in London, but in cities, towns, and villages generally. The plague-stones found in the suburbs of towns and villages attest the prevalence of the disease. These stones were cut to form a trough, which was filled with vinegar and water. They defined the boundary to which the people from the town or village might advance countrywards, and to which country residents might come townwards, bringing their produce, which the town inhabitants must fetch, leaving their money, the price of the food, immersed at the plague-stone, in the vinegar and water. Contamination was supposed to be prevented by these contrivances. Betwixt nations, quarantine was enforced, and is enforced up to this day. The quarantine enforced in London on houses during the prevalence of the great plague is terrible to think about. The blood-red cross and the awful text—'the Lord have mercy upon us'—on the house door, with a guard to hand food and medicine to the sick, and to restrain them from coming about until forty days after their recovery, must have contributed largely to the mortality. It is quaintly remarked, that 'the Lord Mayor's officers readily and effectually put these orders in execution, yet it was to no purpose, for the plague more and more increased; and the consternation of those who were thus separated from all society was inexpressible, and the dismal apprehensions it laid them under made them but an easier prey to the devouring enemy. . . . If a fresh person was seized in the same house one day before the completion of quarantine, it was to be performed over again, which sometimes caused the loss of the whole. But what greatly contributed to the loss of people thus shut up, was the wicked practices of the nurses, who would strangle their patients to rob them, and convey the taint from sores of the infected to those who were well.' Such is a very brief notice of the ravages of the great plague of London in 1665, when there were 97,306 funerals, 68,596 persons having died of the plague, besides many of whom no account was given by parish clerks, and who were privately buried.

The literature of plague, as written at the period, with all the vivid terrors of the disease described, is, for the most part, a record of gross superstition and romance. The plague was real, the filth was real, the terror was real, the sufferings were real, and the deaths were real; but the causes assigned were vague and wild, and the remedies recommended and medicines used do not in all their nastiness bear description. But even in this case we need not rely upon history, as now there is probably as much ignorance, superstition, negligence, and cruelty where plague and famine prevail, as was practised in England during the prevalence of the great plague.

We are frequently referred to China for an example of order and care in the conservancy of excreta for agricultural uses, but upon thorough examination, and a full knowledge of the details, we find that the Chinese example is one to be avoided rather than to be followed. What the state of China is may be inferred from the following remarks, descriptive of a visit to Canton, in the year 1878. The writer says: 'Without much delay we set off on our explorations, and a short walk over the green grass of the Shameen, brought us to a bridge which crosses the moat or canal that divides Canton proper from the foreign settlement. . . . We were astonished to note the marvellous change in the appearance of the surroundings, which the mere crossing of the bridge presented. We had gone from a broad, handsome suburb of a prosperous European community, into a veritable Chinese town, with narrow, irregular streets, full of people, and an atmosphere polluted with the most horrible smells. . . . Leaving this filthy spot, we went on to one even very much worse; namely, the city prison. . . . We went through a labyrinth of passages, and finally found ourselves in a square court, open to the sky, round which were ranged the dens or cells of prisoners, who were in most cases shackled by their feet. The moment we were seen, out they came upon us from their dens in all directions—filthy, horrible creatures, with hands outstretched, swarming around, and clamouring for money.' This description of one of the great cities of China, at this day, represents very graphically the condition of London, Paris, and the other European capitals and towns at the period of the great plague. Travellers do not always note the condition of the inhabitants of foreign countries when first visited. We may be told about beautiful scenery in lakes and mountains, imposing-looking buildings, fine museums, and fine picture-galleries, without one word as to the real state of the population. In the streets of every city in Europe there are indications of the real condition of the people, which an intelligent and practical sanitarian will at once note. The churches may be very noble in outline, and rich with carving, but if squalid, begging cripples surround the stranger, he will know by intuition that, not very distant, there are slums and dens—filthy, stinking, disease-smitten, and disease-producing. The probability will be that in one hour an observant sanitarian will learn and know more of the true condition of the city he is, for the first time, in, than thousands who have been born, brought up, and lived in the place all their lives. It will be a case of 'Eyes and No Eyes.' Sanitary science brings into play all the observing faculties of an educated man.

Past history has, for the most part, consisted of details of the birth, life, and death of kings—of their wars and conquests—with a very slight glimpse of the state of the people. In the future, true history will note and record the condition and doings of the people, as constituting the power of the state; but at present the world is very far from this condition.

When in this age of general improvement in arts, manufactures, and commerce, we find Europe in arms to a greater extent than at any former period, and the people under a load of expenditure the heaviest in the world's history, thoughtful men must pause, wonder, and look for some practicable solution. The taxes now being levied and expended on soldiers, armaments, arms, and ammunition, would more than serve to abolish every city slum and wretched town tenement, admit of the rearrangement of every city sewer, and pave every street, drain every house, provide a full supply of pure water at high pressure and constant service, and pay for daily scavenging. When history can detail these things as accomplished facts, it will be worth reading. Sanitary science is new, but it is not, as yet, popular. To remove filth, to promote health, and to prolong life, gain little of a statesman's notice in the battle of politics; the work has, however, commenced, and is being taken up, both at home and in our dependencies. The Americans are also becoming earnest sanitarians.

There are poverty, vice, and crime in Great Britain which, when contemplated in detail, are quite appalling; and these are the outcome of defective statesmanship—and this after years of political freedom and so-called enlightened government. We sanitarians, however, hold that statesmanship which leaves the largest numerical mass of the population in hopeless misery must be defective. This condition of society is not a sound one; and, consequently, is not a safe one. To see the results of despotism and neglect, in their most aggravated forms, we must, however, cast our mental vision over the empires of China and Russia, where millions of men know nothing of political and civil freedom; the results being civil commotions, rebellions, and civil slaughter, wholesale arrests, wholesale condemnations, wholesale transportations, and wholesale decapitations, which affect nothing worth the trouble, because the wretched people have no cessation to their persecution. They exist in misery, and have no hope.[1]

True sanitary science recognises the unit, man—looks at the individual, the single family, the single house, the village, the town,

[1] *A Bloodthirsty Mandarin.*—The following appears in the *China Mail*:—A tale of peculiar horror comes from the Swatow quarter. The military Mandarin for the Kit Yang district, Pung Tye-jen, who will be remembered as the Mandarin who gave the order for the compradore Ah Pac to lose his head, and was also intimately concerned in the Lee Lum Kwai affair, has been distinguishing himself in thoroughly Chinese fashion. Some small official, who held the position of tax-collector, had been murdered by the people, who, exasperated probably by his eternal and extensive squeezes, considered taking the law into their own hands to be the only way of getting rid of him. For this daring outrage against law and order, Pung Tye-jen undertook to inflict punishment upon the residents, and did so with a completeness we rarely see equalled. He first secured the services of a gunboat to protect or cover his retreat, the place where the inhabitants had done as we have stated being within reach of the guns of a man-of-war. The place was then besieged, and the soldiers killed something like 700, it is said, of the people who were supposed to have taken part in the uprising against authority and had caused the death of this petty official. The number of those destroyed by the avenging army of Pung Tye-jen is variously estimated from 400 to the figure above stated. Surely an ample satisfaction to even a mandarin of the bloodthirsty character which this man has acquired.

and the city, as these constitute nations, and as are the individuals, so must be family, town, and nation. If, therefore, there is ignorance, wretchedness, and vice amongst the lower orders of the people, the leaven pervades the entire nation.

These questions may be termed political, and it may be said that sanitarians have nothing to do with politics. Our reply, if questioned as to this, must be that to govern men is the prime duty of a statesman. But what are the definitions of the word 'govern'? To a despot there is only one definition, and that is, repression; which implies every form of cruelty which man ever devised and practised. To a British statesman I hope it means, to care for the whole people; to educate, and to protect them in all honest dealings; to repeal all laws which tend to the commission of crime, to abolish class legislation, and to know nothing of party if it leads to faction.

The domestic side of sanitary science deals with home comforts, and the unit in this case is the house, then the village, and the town. Houses must be planned, constructed, and regulated to afford means of health and morality to the occupants. Villages and towns must be so arranged, built, sewered, paved, and scavenged as to preserve the purity of the soil below and the air above for the benefit of the inhabitants. To secure such ends, there must be sewers, drains, pavements, scavenging, and a water supply. Sewering is ancient beyond written records; sewering scientifically is, however, modern, very modern, as some of those who presided at the birth of the modern system of town sewering are happily now living. Edwin Chadwick, C.B., though not a civil engineer, has, through the aid of engineers, done more to found and promote the true principles of town sewering than any other single individual in this generation.

There were sewers and drains in the cities of Asia, which are now heaps of ruins. As in these days, so then, where large areas were covered with buildings, and men were aggregated, there would be sewage; and this would be removed by open channels and covered conduits; necessity having been the mother of invention. These ancient cities were, however, not wholly sewered, but only partially. It is very easy to be positive on this point, namely, that sewers and drains were not general, as there are no remains beneath great areas covered by the common people, the ruins of which would have been found if sewer and drain-pipes had ever been laid.

Rome sewered and drained her cities, public buildings, baths, and palaces from a very early period of her history, and the ruins are there to this day. Pliny describes sewers in some of his letters to the Emperor Trajan. There were not only sewers, but there was also river pollution. The great Cloaca Maxima of Rome emptied sewage into the Tiber; and Pliny directs the attention of the emperor to a case in a provincial city, where certain banished men resided, apparently living in ease and idleness. There were sewers in the district, and a polluted stream flowed through it, which had become a great nuisance and was complained of by the inhabitants. Pliny, in this case, suggests that the idle easy-living banished men should be more fittingly punished by being made to cleanse the foul sewers, and for the future prevent river pollution. Trajan at once consents to so reasonable a proposition. These letters by Pliny are most interesting in showing how actively he performed his duties, and how minutely informed he kept the great emperor.

At Sinope, on the Black Sea, money had been advanced to the municipality for a theatre. A bad site was, however, chosen, a swamp, and the building became a ruin before completion, and the money was wasted. Subsequently a memorial was sent to Rome petitioning for money to construct waterworks. Pliny, in this case, cautions the emperor, and advises that, if the request is entertained favourably, an engineer be sent with the money, that the local authorities may not job it away, as in the case of the ruined theatre. I suppose the emperor did send an engineer, as, in 1855, I saw the ruins of the service reservoirs, which, but for man's destruction, would have been as entire as on the day of their completion;—the walls now remaining being sound and massive as when first constructed.

The making of earthenware vessels by means of the potter's wheel is of very ancient date; and the work of the potter has, amidst all the ruins of ancient cities, been the most enduring. The vast collections of bricks, tiles, tablets, pipes, and vases placed in European museums testify to this fact. At some early period earthenware pipes were thrown on the potter's wheel, having sockets for jointing similar to those now made in England. I saw samples in Asia Minor, in 1855, evidently new. They were about 13 inches in length, and 5 inches internal diameter, having a socket of about $1\frac{1}{2}$ inches in depth. They were being laid at Kulali, situate on the Bosphorus, to form a conduit to bring water to the barrack hospital. The natives were at work laying the pipes on a contour line, a considerable length of trench being open. I did not at first see any arrangements for ventilation and wash-outs, and was questioning the engineer officer upon these points, as to whether or not they had been provided for, making a rough diagram, and scratching on the ground with a stick to illustrate my questions. The engineer officer could give no information; but one of the native workmen, who had been listening to and watching us, touched me on the shoulder, and, with a sparkling countenance, said, 'bono-bono,' immediately taking me along the line of aqueduct, and pointing out the structural means I inquired about both for ventilation and for wash-out.

Aqueduct making is a very old Eastern practice, aqueducts, fountains, and wells being common all over the inhabited parts of Asia. Water, as one of the elements necessary to life, was, in a warm climate, sought for and stored carefully. A very meagre history of springs and wells would form a large book, and might be as interesting as the most vivid romance. There are holy wells throughout Asia, and there are also holy wells and fairy wells in Europe, novelists having with great effect availed themselves of these superstitions, and woven them into their descriptions of supernatural phenomena. There is, in fact, an enormous amount of superstition, romance, and poetry connected with springs. Magical virtues are attributed to many waters, a belief in which leads to incalculable injury.

There are shrines in India within which are reputedly sacred waters, to be washed with, and to be drunk by the pilgrims to secure eternal salvation. On certain days in the year thousands of the natives assemble and encamp round these sacred shrines. The approach to the holy water is by a flight of marble steps, down which perspiring natives, many of whom are crippled and diseased, throng to have a cupful of the fluid. The practice is to pour a cupful over the head of each native, to flow back to the tank, and this is repeated hundreds of times during the day, so that it ceases to be water and becomes a vile compound—the washings from the bodies and feet of natives, and this horrible decoction the priests in attendance administer to be drunk by the poor besotted votaries. Cholera usually breaks out amongst the pilgrims at these gatherings, and it would be contrary to the known laws of sanitary science if it did not do so.

Recently there has very properly been a rage for water analyses, many thousands having been made in Great Britain and in British India, and very startling conditions have been revealed. Water which has been considered pure by the inhabitants of English towns, has been found to contain a dangerous proportion of polluting matter, to the effects of which they appear to be stupidly apathetic; but the researches in India reveal a state of things almost too terrible to contemplate. The natives of India are expert diggers of wells and formers of tanks, to supply and store water for use; they are also careless of life, committing suicide with apparent avidity, death by drowning being common. It had been observed that at certain Indian stations British soldiers were liable to be afflicted with virulent types of disease—as cholera, fevers, and at Delhi carbuncles and sores, the Delhi sores having become a recognised affliction. Inspection was ordered, when it was found that within the province there had been about 1,700 carcases of human beings removed from tanks and wells, the water from which had been regularly used for human consumption. Some of the worst wells were ordered to be cleansed, when many human bones were removed from them. The tanks in use are open, and the surrounding ground slopes towards the water; over the surface human excrement is spread, and the natives both wash clothes and bathe in the water they use for cooking and drinking. High caste apparently affords no protection, but acts in a contrary direction. Calcutta is supplied with filtered water, but high class natives decline to use it. A native water carrier was observed filling his skin at a stand-pipe with filtered water, but when about three parts filled, he went to the nearest puddle, and with his hands proceeded to fill his vessel. An Englishman, observing him, asked what he was doing, when he replied, 'Making Ganges water for master.'[1]

Some medical men state that pure water is absolutely necessary to health; others send their patients to drink the most abominable compounds at English and foreign Spas. Pure water is a rarity in nature, and where it is found it must be protected with great care, as it is a powerful solvent and greedy of impurities. The solvent property of rain-water, which is the nearest approach in nature to pure water, is probably amongst all the elements the most powerful agent in moulding and disintegrating the solid earth. By way of illustration, the river Thames may be taken. The water of this river contains, in round numbers, about one ton of bicarbonate of lime in each million of gallons, when the water is clear, bright, and sparklingly transparent. The daily supply pumped into London is now about 135,000,000 of gallons, so that 135 tons of bicarbonate of lime are combined with the supply of each day's water, or upwards of 49,000 tons per annum. The average flow of water down the Thames may be taken as 1,000,000,000 gallons per day; so that about 365,000 tons of bicarbonate of lime are washed down per annum, from the Thames alone. About four-fifths of the dry land of the earth contain lime, or are limestone, upon which this dissolving action of rain-water is unceasing; so that the whole of the solid earth above sea-level may be silently washed and wasted down into the great salt ocean. Soft water, being so powerful a solvent, is economical for washing, but it is vapid for drinking, and is liable to produce diarrhœa when peat-tainted. It has not been proved that hard water (hard as Thames water) is injurious to health: it has, however, been demonstrated that it is a great protection to health, when it has to be brought into contact with metals—lead, zinc, and some other substances.

It is the duty of the sanitarian to obtain clean water, and to preserve it fresh, cool, and clean; but pure water—in the full sense of

[1] Great improvements have been made at stations throughout British India in improving and in guiding water supply sources, both tanks and wells. To prevent pollution these improvement works are now going on.

the word 'pure'—I do not believe to be necessary to health, since spring, stream, river, and well waters necessarily contain salts of the rocks they come into contact with. These are the waters, which are the most widely obtained in nature, and in by far the most cases can alone be obtained, and must therefore be accepted.

Contaminated water must be dangerous and should always be avoided. Contamination is not, however, the most dangerous when the water is most visibly polluted. The turbid waters of the Nile, in Egypt, and of the Ganges, in India, are taken for use in preference to all other water. These mighty rivers are, however, usually turbid, the suspended silt acting as a disinfectant.

The filthiest and most dangerous water to drink is well-water, tainted with human excreta, which water may be clear and sparkling. Surface-water flowing down brooks and rivers, though visibly polluted, does not appear to be as injurious as tainted well-water; earth and air being purifiers of surface-water. Water when enclosed and stagnant, as in wells, pipes, or small unventilated tanks, and especially when affected by liquid or gaseous impurities, becomes stinking and unwholesome.

In water-works the water to be impounded in reservoirs should be gathered from the cleanest possible sources, and should be preserved clean.

Sand-filters should be close to the service-reservoirs, which should be covered and fully ventilated.

The supply from the reservoir and the supply mains should be direct, and the mains should be so laid and connected as to produce continuous circulation, as water retained a long time dormant in "dead-ends" rapidly becomes deteriorated. The best water-supply will be one which secures the purest source, and by the works of storage and distribution preserves it the purest up to its delivery for use.

Bathing and washing are necessary to health, but there are many towns in Great Britain and Ireland without adequate means for bathing and washing; and, as a consequence, the people do not bathe and are not clean.

Baths are common in better class houses, though by no means as common as they should be. The '*tub*' is, however, used as a substitute.

The poor cannot provide their own baths. These ought, therefore, to be provided for them by the Municipal Authorities in the best and cheapest form, and in the most convenient positions. With the baths should be wash-houses, where water, soap, and all the apparatus necessary for clean and rapid washing, drying, mangling, and ironing, should be made available at the least practicable cost. If sites are judiciously selected, and there is no extravagance in the construction and management, there must be no loss. But a small rate in aid, if required, will be a saving indirectly in promoting cleanliness, sobriety, and improved health.

The same writer I have before quoted remarks that in Japan bath-houses exist in great numbers in the towns, where warm water is provided at a small cost. These baths are for the benefit of the poorer classes, who use them in great numbers—as regularly as evening comes crowds of Japanese men and women go to bathe. There are ranges of box shelves where the clothes are placed, whilst the individual steps into the bath, emerges from it, well rubs the skin, dresses, and departs clean in person. In Great Britain, at this day, thousands upon thousands of the poor are never washed clean from their birth to their death, unless they go to prison, or to the workhouse. There is no bathing accommodation provided. At all schools there should be baths, and complete washing should be a part of education, as those who are accustomed to regular personal washing in youth will not subsequently abandon it.

Sanitary science has, during the last half century, probably made most progress in England; but then this island is a very small spot on the globe; and even England—free, rich, compact, and educated as it is—only progresses slowly. It may, however, be interesting to this meeting to learn that there is an Association of Municipal and Sanitary Engineers and Surveyors to the number of 205, and that 197 towns and districts are represented by the members. The extent of work executed might be indicated by the make of earthenware pipes and other sanitary articles, if a reliable return could be obtained. The Messrs. Doulton are making about 1,300 miles of drain-pipes per annum, besides many thousand soil-pans; and this may be about one-tenth of the entire English make of sanitary articles.

There is not time in a public address to deliver a closely reasoned essay, and a popular address is not, I assume, expected to be other than discursive.

The following remarks may interest the public, though they may not teach much to the educated engineer.

SEWERS AND DRAINS.

There are good and bad sewers and drains, and the public should know some of the reasons why this is so, and then they may refrain from condemning sanitary works in general.

Sewers and drains have been formed, which are so defective as to be a cause of serious nuisance; they are too large, have wide and flat bottoms, the materials are bad, and the construction worse.

It is possible to damage a town by defective works, and so bring discredit on sanitary science. I will attempt to describe how a town ought to be sewered, and how houses ought to be drained, to fully answer the purposes intended.

Correct plans and sections are required upon which to lay out the system of sewers and drains to be constructed; the depths of the cellars should be figured on the sites of houses; the relative levels of the streets may be indicated by contours, and on the sections the strata should be shown by colours.

A careful engineer will test the strata, by boring and trial holes.

Full details how to lay out sewers in right lines, both on plan and in gradient, are given in the 'Suggestions' published by the Local Government Board.

An engineer should settle at the commencement what duties the sewers will have to fulfil. If the town has manufactures consuming and polluting much water, the question may arise, if or not this polluted water is to be removed by the town sewers. There will also, in some cases, be a question of injurious fluids, such as tan-pit refuse and pickle-waste from brass founders, lacker manufacturers and tin-plate makers; there are also dye waters, and soap-waste from woollen manufactures. Some of these fluids can be treated on the premises so as to precipitate the solids and to disinfect and clarify the fluids, and, consequently, where there is no land available for sewage filtration, the manufacturers may reasonably be called upon to clarify their polluted liquids, and not pass them in their crude state to the sewers.

There are wet and dry subsoils. Sewage will, from good gradients, flow to any point required by gravity; in other cases there may be a flat area with a wet subsoil, and a swamp for an outlet, or this may be below the river or sea level. In such cases pumping may have to be resorted to, and then it is desirable to reduce sewage to a minimum. The subsoil should have independent drainage, and the sewers and drains should be water-tight,—surface water, including rainfall, being otherwise provided for.

To construct water-tight sewers and drains requires the best materials and the most careful workmanship, but these indeed are necessary under all conditions. In a wet subsoil land-water should be excluded, in a dry subsoil the sewage should be prevented from leaking out of the sewers. In the foregoing remarks extreme cases of wet and dry are contemplated. If sewage has to be pumped, and has to be clarified by irrigation, the volume to be dealt with should as nearly as practicable be a constant quantity. If, however, there is a free outlet by gravity, the sewers may be allowed to partially receive both subsoil and surface water; only, however, to some known and limited extent. It is an advantage to have a wet sewer rather than a dry one. Sewage flows intermittently, during portions of each day, when the inhabitants are using most water; if there is no subsoil water, the sewers at intervals may be comparatively dry, admitting of deposit. A steady continuous flow of water through sewers sufficient to maintain a regular current, and not more than a few inches in depth in the main sewers, will be an advantage.

Main sewers should ordinarily be laid at a depth sufficient to admit of the deepest cellar being effectively drained; the invert of the branch-drain being at the least twelve inches below the cellar floor, the fall of the house drain being not less than one in sixty, and entering the main-sewers not lower than half its diameter. These remarks are of course general, and cannot in all cases be acted upon, as many towns have low sites which cannot be effectively sewered and drained without special means (air valves) to prevent cellars being flooded by back-water from the sewers, or by special pumping.

House drains, as a rule, should be outside the basements of the houses. But where houses are built in streets, and the kitchens are at the back, the drain must cross the basement, unless back drainage is adopted, when no drain need enter the basement.

Much has been written and said both in favour of back-drainage and against it. I have had twenty years' experience of back-drainage, and know nothing but good of it. It has been said that it is an interference with the rights of private property; that the drains will choke, and then there must be trespass to find out the point of failure. My reply is that back-drains may be so laid that nothing but gross usage, amounting to wilful action, can choke them; and even in such a case they may be freed and cleansed without trespass, as manholes and flushing will enable them to be so cleansed.

To enable sound sewers and drains to be constructed, the trenching must be true, and the bottom to receive sewer or drain must be absolutely sound and solid. There must be no mistake here, or the work will soon be a nuisance and a ruin. Sewers and drains may become broken-backed; there will then be leaking joints, or saturated subsoil, and a choked sewer or drain will bring discredit upon sewering. If the bottom of a sewer or drain-trench is not sound, it may be made so by cement concrete, and in loose wet quicksandy ground sewers and drains should be covered with concrete.

Sewers and drains will work better, and be maintained in better order, if subjected to regular and properly graduated flushing at short intervals. It is possible to overflush, and so injure the sewers. As much water as will give a velocity of about six feet per second may be admitted; greater force, to give a quicker velocity, will be liable to injure brickwork, and blow or force open pipe joints.

Waterclosets and sinks should be against outer walls; should not have continuous flue-like connections with the sewers, but have a severed connection, and means for full external ventilation. Every public building, however large, and every house, however small, should be so drained as to afford no possibility of sewage gases entering, and they should stand absolutely free from the sewers, though perfectly connected with them. This may be a law without any exception. At present almost every public building and house in London is in direct communication, by the drains, with the sewers, so that sewage-gases pervade them. There are open sewer ventilators in the streets, which serve to dilute the sewage gases, and the enormous number of houses perform a similar purpose. It is this dilution which prevents the full amount of mischief from being experienced; but there is a danger in it, and this ought to be avoided. This is to be done by absolute isolation, and external ventilation above the roofs of the houses. In Leeds, for a population of 320,000, there are upwards of 20,000 openings from the sewers acting as ventilators, which have been in use more than seven years. This is an example other towns may follow with advantage.

Perfect sewering requires perfect street paving and perfect street cleansing. Scavenging must, in all cases, be a work of the municipality, or other local governing body. Contract work should be avoided. The work of scavenging should be paid by rate, and this rate should be general.

Waterworks should, in all cases, be in the hands of the local governing body. The service should be constant and at high-pressure, with fire-service provided for. Water should be laid on to every house and to every tenement; there should be no exception. The service-pipes may be of wrought iron, with screw joints, and all the taps should be 'screw-down.' If the services are taken within the houses and tenements, and the service is high-pressure and constant, there will not be much wilful wasting of water, and house-taps will not be stolen, as waste of water, when at high-pressure, will be very disagreeable within a house. Fix stand-pipes in streets and roads, as is done now, and the waste will continue to be unceasing, because it will not inconvenience any one, as when it is within doors. The poor cannot have a full and fair use of water if it is alone obtainable from external stand-pipes, as this involves carrying and storing within the tenement. It should also be remembered that one gallon of water weighs 10 lbs. and that fifty gallons weigh 500 lbs., and this will be only ten gallons per head for a family of five persons. The labour required to carry 500 lbs. of water each day, or 80 tons per annum, will be simply enormous, and ought not to be expected from the poor tenant. Serve the water within the house, have necessary supervision, and take charge of repairs; the inhabitants will then be properly supplied with water, and cannot easily waste it. Before closing these brief and imperfect remarks I may glance at a few works recently executed, or which are now in progress.

Calcutta has been partially sewered, Bombay is now in course of being sewered, and preparations are in progress for sewering and draining other Indian cities. Sewerage works at Berlin are also in progress, to be completed with sewage irrigation. Dantzig has been completed, with sewage irrigation added; and main sewerage plans are being prepared for other continental cities. At Warsaw, with a population of 350,000, the estimate for sewers is 600,000*l.* Buda Pesth, population 270,000, main sewering under consideration. St. Petersburg, population 670,000, estimate for sewers 3,000,000*l.*, to include pumping and sewage purification. Munich, population 250,000, estimate for sewering 600,000*l.* Dusseldorf is to be sewered by Messrs. Lindley, of Frankfort. Messrs. Lindley have sewered Frankfort-on-the-Maine, population 125,000, cost 380,000*l.* Out of 6,800 houses, 5,200 have been completely drained, and in the town there are about 22,000 water-closets. At present, the sewage goes into the river Maine, but it is to be intercepted and clarified. The Prussian Government insists on sewage clarification, which, at present, is stopping sewering on the Rhine cities, where it is very much needed.

The water of the Rhine is, however, used for domestic purposes by the population on its banks, and it ought, therefore, to be preserved free from sewage.

French and Belgian towns remain with cesspools. Even Paris and Brussels, with their enormous and costly main intercepting sewers, are cities of cesspools, and I do not know of a single well-drained city in Italy. We are met here in this ancient city of Exeter to discuss sanitary science and preventive medicine, engineering and sanitary construction, meteorology and geology—to give information and to receive information on subjects which we consider to be of vital importance to each individual man, to each town, and to each nation; but when we read the current newspaper literature of the day, we seem as men beating the air. Statesmen pay very little attention to our subjects, but starve labour by conscription, impoverish populations by taxation, and, at enormous cost, provide the most refined and terrible weapons for human destruction. We are in the midst of a war furore, and sanitary works can have no solid and satisfactory progress under existing conditions. There is over the length and breadth of Europe a rampant military spirit; armies, armaments, ironclads, and 100-ton guns, attract most attention. The people are summoned from far to witness autumn manœuvres conducted by emperors, as if soldiers were the beginning and ending of human progress and civilisation. The Americans appear to be the only sane nation. The governments of the old world are drunk with military ambition.

Lord FORTESCUE proposed a vote of thanks to the President for his address. Mr. Rawlinson had spoken with much knowledge, and after long practical experience, of one of the most important sanitary subjects, in all its bearings, which could be considered for the benefit of the community.

Dr. RICHARDSON seconded the motion, and said that those Sanitarians in London, who for the last thirty years had been most prominent in sanitary work, had always looked up to Mr. Rawlinson as in his way perfect, and as one whom they could trust in whatever he said. The solidity of sanitary development in the direction indicated by Mr. Rawlinson had been vastly owing to his skill and judgment, and, above all, to his truth.

The MAYOR of Exeter said he should like to support the motion. The address was one of the most exhaustive he had ever listened to. It was most fortunate for the city that the Congress had come to Exeter, and still more fortunate that that section should be presided over by Mr. Rawlinson. The Mayor hoped before that gentleman left he would still further advise them on sanitary matters connected with the city. It was a matter of regret that the city was not yet sewered on modern principles, but the local authorities would now have the advantage of the advice of such gentlemen as Mr. Rawlinson to assist them. Mr. Rawlinson informed him that the city might be cheaply sewered. He was glad to hear that, as it had been to him, and many other gentlemen in the city, a matter of considerable anxiety, owing to the feeling that the expense would be enormous. He was, however, told by Mr. Rawlinson that the city could be even better sewered in a cheap than in an expensive manner. The visit of the Institute would well repay the citizens for the trouble they had taken and for the pleasure of entertaining its members.

Mr. CHADWICK, C.B., in supporting the vote, said that in the many years Mr. Rawlinson had been engaged in advancing works of sanitary improvement he had displayed one great qualification—that in no instance had he exceeded the cost of his estimates.

The vote was then carried and acknowledged.

The Water Supply of the Louth Rural District.

AT a period when the public attention has been directed to the great question of a national water-supply, a contribution on this subject may possess some interest. Louth Rural Sanitary District comprises eighty-nine parishes, somewhat unequally divided by the 'Wolds,' those on the east lying in proximity to the sea, the country being flat, and the soil, for the most part, being a rich loam, of the drift and post-tertiary formations, overlying a clay subsoil. On the west the country is hilly, dipping occasionally, with loose soil covering the upper and lower greensand formations, overlapping the calcareous strata in connection with the 'Wolds.' As in most chalk formations, the water-supply is ample; but boring to the depth of 100 yards in some localities is ineffectual in procuring water, whereas in most of the marsh villages overflowing springs and 'blow-wells' abound. This latter designation is applied to springs where the water flows to a considerable height, owing to the pressure exercised by the water-bearing strata in the hills.

Having thus given a general outline of the sources of water-supply, I propose to describe the distribution of it as regards meeting the wants of the population; and, before doing so, I must observe that no water can be considered reliable which is not obtained from a rock source. In many villages near the coast, such wells are scarce, as the surface water obtained from the gravel overlying the clay is much more accessible, but of course objectionable, being liable to pollution.

In approaching the coast, the difficulty of reaching the underlying rock is, of course, increased, especially at Mablethorpe, where the water is generally brackish, and it is only in certain districts that deep boring is attended with success. It has been a source of anxiety to meet the wants of this favourite seaside resort. All the springs are affected by the tide; and an analysis of a sample of water from this place by Professor F. de Chaumont, F.R.S., indicated 92 grains of solid matter per gallon, while the hardness showed 59 degrees of Clark's scale. These facts are doubtless discouraging; yet an enterprising proprietor, at the suggestion of Professor Frankland, has adopted the softening process, by means of quicklime, with very good results; and, after filtration, he has succeeded in producing a wholesome and potable water. This, however, is an individual case; but the problem of supplying the inhabitants generally is not yet solved, and should the place become populous, some other plan must be devised.

The town of Louth, containing 10,750 inhabitants is mainly supplied by a company, which has utilised the 'Silver Spring' lying adjacent in the Wold Hills, though many houses have wells on the premises more or less impure. Many of the latter class have, however, been improved of late years, and the zymotic death-rate of Louth for 1879 was 1·9 per 1,000, which speaks well for the general salubrity of the town. The rural district death-rate for the same period was 1·29 per 1,000. Preventable disease has not been rife. Typhoid fever scarcely exists in our midst; and out of a population of 24,750 only one death occurred from it in 1879. The autumnal diarrhœa contributed the largest number of deaths under the zymotic class, and did not appear to be influenced by the water-supply. These results have been mainly brought about by close attention to the wells of the district under the powers given by the recent Act of Parliament, and many new ones have been sunk.

In some of the large farmsteads, rams have been constructed; and in others, where well-boring was impracticable or difficult, brick tanks, cemented inside, have been constructed, to hold 1,500 gallons, at a cost of 20*l*., to supply double cottages. Iron tanks are in use, but are not generally approved of. Believing as I do, that a wholesome water-supply is the great factor in promoting the public health, I have offered these remarks in the hope that attention may be drawn to a district purely agricultural, where much has been achieved, even in these depressed times, by a vigilant attention to the water-supply, without embarking in any ambitious schemes, and relying solely upon the proprietors giving a loyal support to the intentions of the Legislature, under the guidance of the sanitary authorities; for we have to look for improvement in sanitation, not only to the co-operation of capital and labour in the initiation of schemes for an improved water-supply, but also to the patient investigation of the evils which lurk in many a domestic household, and only to be removed by the exercise of the powers we possess for their mitigation and removal.

In conclusion, let me review some of the suggestions which have been put forward on this topic, and consider which are applicable to the district which I represent. It has been proposed to supply villages by pipes from distant sources—say the Wold Hills in the Louth district. This plan is clearly too expensive, and must be dismissed, except perhaps in the instance of Mablethorpe, on the coast, and the villages intervening between it and the proposed source, ten miles distant. The river-catchment system, as advocated by the Royal Commission in 1869, by which each should supply, as far as possible, its own population, is inapplicable here, except in a limited form, owing to the pollution of the principal streams by sewage. Artesian wells might be resorted to with advantage, superseding gradually the surface-water too frequently in use; and, lastly, the rainfall should be utilised for individual houses and farmsteads. It would be foreign to my purpose to dwell upon the system of main drains and dykes, under the supervision of the Commissioners of Sewers, for watering cattle, &c., as this source is condemned by sanitarians as impure for domestic use. My object in bringing forward this subject will have been attained if I am able to elicit in the course of a discussion any suggestions for the improvement of the water-supply of my district.

RICHARD DOMENICHETTI.

Water-Closet Construction.

GREAT importance must necessarily attach to the deliberations of an Institute like this, which aims at disseminating information, and guiding public opinion on sanitary matters. It may, however, be questioned whether the real importance of a given subject is not shown less by the amount of talk to which it may give rise, than by the amount spent upon it in the production of an article the best fitted to meet advancing requirements.

The amount of brain-power and hand-labour expended for many years past in invention and experiment for the production of a perfect water-waste preventer and regulator, and an unexceptionable water-closet apparatus, is alone sufficient to testify to the paramount importance of investigation into the proper principles to be followed in their construction, with the view of arriving at some intelligible lines within which they should be restrained.

To all who have taken an active interest in sanitary matters, nothing can have been more evident than the dangers attending the old system of pans and valves, with D traps fixed out of sight, inside the house. At the annual meeting of the Parkes Museum, Sir William Jenner spoke of these last in no polite or measured terms. And truly the terms used by him were not exaggerated. But the difficulties attending the amendment of an established state of things with the British citizen are almost insurmountable, especially if it be such as to touch his inner man, whether through the pocket, or (if there be such) some equally tender point. Unquestionably there are vast commercial interests which stand in the way. So far as can be judged by outward appearances, under the present state of things, even the value of the great bulk of house property is but little affected by the presence of sanitary or unsanitary arrangement in these respects. On a recent occasion in a house in which I have sojourned, and in which there has been constant ailment with one or more of the inmates—to say nothing of several cases of blood-poisoning attributed by the medical attendant to sewer gas—I have endeavoured in vain to induce the landlord to provide a water service for domestic purposes, apart from the only one which is supplied from a cistern over the water-closet; this closet being served by the customary spindle valve, with water-box, which inevitably releases the bad air from beneath into the water at the bottom of the cistern. I appealed to him, further, to remove, and to ventilate, the decayed and constantly leaking lead soil-pipe (occasionally eaten through by rats from the drain), which runs down inside the house, adjoining one of the sitting rooms, leaving it in an almost chronic state of stench. And, more than this, I appealed to the sanitary inspector, but could get no redress in these matters. This landlord, being also the agent of an enormous house property, was imperturbable alike under threats of quitting and under appeals to authority. There is every reason to fear that such is no uncommon case. In the great mass of speculative building hitherto, a few pounds per house of additional outlay, in these respects, has not been considered remunerative by way of investment. The houses must be had, and are often occupied almost before they are properly completed, irrespectively of these trivial considerations, about which it is said meddling people make so much fuss. People have become habituated to it. No death in *their* families has been traced to such causes. Almost all houses are alike in these respects. There is but little choice, and other occupants have lived on without complaining. Surely there cannot be so very much the matter, or we should hear more about it, and we can only go on as others do, and if we tried to examine into the matter ourselves, we should be no wiser. We must take what we can get, and either grumble or be thankful as the case may be. This, I venture to say, without exaggeration, is the prevailing state of feeling, and mode of action, or rather of inaction, in these matters.

The remedies usually proposed for this state of things are, first, legislation for the enforcement of sanitary conditions; secondly, the education of the masses to understand and appreciate their own true interests, and to insist upon these being respected. Excellent remedies in their way, and they will doubtless effect much. But the difficulty of a general application of them meets us at every point. The great precedent remedy must be looked for mainly in the production of satisfactory sanitary apparatus and appliances, of the greatest simplicity, and at the most moderate cost; and then at imparting information respecting their principle, and their practical application, to the more educated classes of persons, and to those through whom such appliances are brought into use; rather than in any amount of crusade against mere recklessness, ignorance, or prejudice.

Let me now endeavour to give effect to the foregoing remarks, by a few practical considerations as to water-closet construction. I would, in the first place, deprecate the use of all closets by which, on the pulling up a handle, the contents are dropped down by means of the withdrawal of a plug, valve, or pan, whether into a trap, or directly into the soil-pipe and drain itself. Apart from valves and plugs being liable to derangement, it is evidently possible, and in many instances of accidental deficiency of water extremely probable, that they may be used without water, to the great danger of corroding the pipes and choking the drains. Secondly, I would eschew everything but some description of hopper-basin or flushing-pan. The contents of these *cannot* be let down, to the great danger of soil-pipes and drains. In case of the water service failing, or being frozen up, or otherwise deranged, a pail of water poured down will carry everything away safely. Thirdly, I would have the best possible flush of water which can be obtained by a regulator, or waste preventer, constructed without any valve except only the ball-valve which supplies the 'feed' or serving cistern. Fourthly, I would in all cases insist upon the use of this feed cistern, or other intermediate receptacle, for cutting off completely all contact between the closet and the main service, or house cistern, which may then be placed at any convenient distance from the closet, whilst affording the opportunity of regulating, accurately, the amount of water to be used for each discharge. Fifthly, I would avoid all traps except the one which is formed in the construction of the hopper-basin; this being made to flow out into a ventilated or open soil-pipe, which again may be carried up within an external ventilated flue for protection from frost, or for carrying off the foul air more effectually. There have been several inventions which I cannot regard as wholly satisfactory, with a system of flushing which merely washes out the contents of the basin into the trap below; in which the contents commonly are only partially concealed, and which does not clear itself properly with any ordinary flush of water which can be let in upon it. They are, however, a wonderful improvement upon previous descriptions of hopper-basins, and of still greater value as aiding in the superseding of closet valves and pans. The old hopper-basin has in the main worked far better than these, but the small stream of water, through an insufficient nozzle, has been quite ineffectual for its proper cleansing. The 'Shrewsbury' patent basin made by F. Peirce and Co. is calculated to meet most of these objections. But invention has been rife in the direction of valveless waste-preventers for the flushing of closets in the manner which I have indicated. Of these Hailstone's patent, and Brathwaite's patent, appear to be excellent, if the stream discharged is sufficient. The water is discharged through a syphon which is set going, in the one case by immersing a block of terra cotta to raise the water to a sufficient height to fill the syphon; in the other by raising a small quantity of the water in a cylinder. By the 'Shrewsbury' patent the result is produced by the mere process of lifting out of the regulator, or feed-cistern, the requisite quantity of water in a pan or tray, and so tipping it into a funnel, thus securing the sudden and effectual flush which is required for the specially formed basin or pan.

It surely is to the fulfilment of such conditions as these that all our efforts must be turned, and the stream of invention directed; as indeed, latterly, it has been to a great extent. If there are principles in closet construction radically wrong and bad, and there are others which are essentially true and good, it is only by thoroughly sifting the one and the other that just conclusions can be arrived at, and advancement made. I have not been advancing theories without giving, as I conceive, good and sufficient reasons for the general principles which ought invariably to be followed. Let them be well weighed, and if they cannot be defended, let them be amended. Whether they be accepted as good and true or not, I cannot, I am sorry to say, conceal from myself the fact that they are not likely to be generally carried out, at all events for a long time to come, even with the most strenuous efforts of sanitarians to enforce them, either by precept or by law. The present state of things has too firm a hold on the people at large; and there are commercial principles at stake, which will greatly stand in the way of such a general improvement.

I am not one to advocate interference with personal rights or vested interests, and I may therefore state freely what I believe to be the almost insurmountable difficulty attending it, even supposing a general agreement as to this system being the best. The best and largest firms necessarily live by advertising. And enormous is the good which they have effected by spreading the knowledge of improvements. Advertising is the only means by which such things can be brought before the public; and that which will pay, and will meet the public requirement, howsoever bad in principle it may be shown to be, must not be omitted from the catalogue of the useful articles supplied. The good and the bad are *equally set forth, side by side.* The generality of people take the recommendation of a thing in this manner, and are only too glad to take what is thus brought before them without further trouble or question. And so long as great variety of opinion upon these matters exists amongst those who are supposed to be well informed, it is not to be wondered at that so little real result should be obtained. With all this, however, we are far in advance of our continental neighbours. At Berlin, and at Rotterdam, they rest content, as it was described to me a few weeks since by well-informed persons, with merely a pan and a tap; and nothing could be more simple. At Dresden, Hanover, Bremen, and Hamburg, much more attention is now being paid to these mundane things; but one's reminiscences of continental sanitation are by no means pleasant. I am not at all sure that the same remarks might not be made by a casual observer, as to the state of the case in our own country; for as yet, I fear, we are after all but little in advance of them, and that typhoid fever, certain skin diseases, and much general debility and ill health, will continue to be, as now, but too common; for up to the present time all that has been written and said by our most eminent physicians and sanitarians seems to have made but little practical impression on the educated, the heads of families, and house-owners generally.

William White, F.S.A.

Mr. Martin, C.E., said that he agreed with what had been said as to the defects in the D-traps, which he had experienced in his own house. He believed that there was nothing so efficient as a syphon-trap.

Mr. Robins and Mr. Chadwick spoke in similar terms.

Mr. Towle repeated that the whole present system of closets was bad; the sewerage should be taken away direct and sent over the land.

Mr. Chadwick said that he had often observed that the most healthy of all buildings was a prison, and in every cell there was a pan. According to Mr. Towle's theory prisons would be a source of poison, whereas they were the healthiest places in the community.

The President, in proposing a vote of thanks, observed that where there was a connection between the sewer and mains and the soil pan, it should be immediately severed, and the supply should be either by hand or through a sewer-box.

The vote was seconded, carried, and acknowledged.

The Plan adopted by the Local Board of Health for the Urban District of St. Thomas the Apostle, in the County of Devon, for Disinfecting the Sewage of the District.

The subject chosen for this paper, being a history of the introduction and carrying out of a system commenced at the end of the year 1860, and continued to the present time, with no alteration in its principle, is intended to be a narrative of facts and not a challenge to other systems which may have been adopted with equal success in other places.

Suffice it to say that from the low lying level of our Sanitary District we have laboured under many difficulties which do not present themselves in other more favoured localities.

I cannot do better than quote from the minutes of the first meeting at which the present system was suggested as a remedy for the evil arising from sewage not disinfected.

For access to these most valuable and ancient minutes, I have to thank Mr. J. Champion, now the clerk to our Local Board of Health, who most courteously placed them at my disposal, and to whom I am indebted for much valuable information.

'At a monthly meeting of the Local Board of Health for the district of St. Thomas, held on the 3rd Dec., 1860,

'James Wentworth Buller, Esq., M.P. in the chair, Mr. R. T. Pince called the attention of the Board to Mr. McDougall's scheme for disinfecting and dealing with the sewage at Carlisle, and produced a correspondence respecting it recently published in the "Times" newspaper. After the matter had been well considered, the Clerk was directed to write to the Town Clerk of Carlisle, and to Mr. McDougall at Manchester, soliciting information on the subject, and to call a special meeting of the Board when the answers were received.'

On the 21st December of the same year, 1860, Mr. Ellis, the Surveyor, was requested to go to Carlisle to inspect their system, and to meet Mr. McDougall there, together with the Town Clerk of Carlisle. He also visited Rugby, and the result was that on Mr. Pince's proposition, which was unanimously agreed to by the rest of the Board, the disinfecting process there adopted was tried at St. Thomas for three months. After this time there are reports as to its satisfactory working.

The system was, after this, further extended, and satisfactory experiments were tried as to the fertilising properties of the disinfected sewage. (2nd September, 1861).

After this, at a monthly meeting on the 4th August, 1862, J. W. Buller, Esq., M.P., in the chair, Mr. Northmore submitted the draft of a letter he proposed to send to the authorities of the city of Exeter on the subject, and on the advantages that would accrue if Exeter would join St. Thomas in carrying out the scheme. At the same meeting it was proposed to exchange the old basket-work screens for perforated cast-iron panels, $\frac{3}{8}$ths of an inch in thickness, for filtering the sewage.

Then we find details of the sale of the solid sewage.

In the beginning of 1863 we find the Board considering the practicability of using the valuable liquid portion containing the soluble salts of the disinfected sewage for the purpose of irrigation. For this purpose, owing to the low-lying level of the works, it was deemed necessary to have a pumping engine to raise the sewage, but this was not carried out.

This disinfected fluid still continues to flow a considerable distance, until near Countess Weir it passes into the river, being thus lost to agriculture; and I may here observe that having been treated with carbolate of lime it would, if allowed to flow over the level lands adjacent to its channel, produce a good effect on the pasture, and not be open to the objection which attaches to all other sewage water, carbolic acid being a wholesome detergent, and even in its greatly diluted form curative in its effects and antiseptic. It is therefore helpful against 'footrot' or 'flukes,' as it would destroy slugs, especially when combined with lime; and though perhaps not sufficiently strong to cure footrot, it certainly would have a beneficial influence on sheep so affected.

This history would be incomplete were I not to quote here an admirable article from the facile pen of a gentleman who was on the staff of the 'Exeter and Plymouth Gazette.' The paper bears date September 20th, 1867, and I must tender my thanks to Mr. Donisthorpe, the present editor, for his great courtesy in furnishing me with it. It is headed 'Our City,' and contains an excellent account of the sewage operations in the parish of St. Thomas, and the formation of a new water supply for that district.

OUR CITY.

There is not much distinction to be drawn between a citizen of Exeter and an inhabitant of the parish of St. Thomas. Both hail from Exeter, and each has the same pride in the old city. In local government, however, there is a difference between the management on one side of the river and that on the other. Invidious comparison ought not to be drawn between the two. The circumstances of the single parish and those of the great city are very different, and the authorities of the smaller place are in the better position to make experiments. Still the St. Thomas Local Board of Health have acted with great spirit in the important matter of the sewerage and the water supply, and now that they are preferring certain charges against the city authorities, it seems an opportune moment, on the part of our city, to endeavour to ascertain exactly what the parochial Local Board are doing, and what actual grounds of complaint they have against us, and against the Water Company of the city, which has hitherto supplied both Exeter proper and the transpontine district with water.

While the whole country has been agitated with the question as to what shall be done with the sewage of towns, and every new system adopted has been discussed with the greatest interest in a hundred other towns, anxiously waiting to have a method propounded to them to relieve them of the difficulty in which they are placed, the parish of St. Thomas disposes of its sewage in a simple and comparatively inexpensive manner, and avoids the objections which have been raised against almost every other suggestion that has been made in the shape of a solution of the question, for it neither pollutes the river, infects the atmosphere, nor destroys the manure. The St. Thomas's sewage system, which has been inspected by deputations from a large number of towns, and from scientific and other societies, must be familiar to a large number of persons in Exeter; but since the Local Board have very recently completed the works so as to apply to all the dwellings in the parish, and that completion has a particular bearing on the application recently made to the local authority of the city, we will briefly explain the plan which has been found so satisfactory in that parish.

Some ten years ago, about 1857, the authorities of St. Thomas made an attempt to adopt Mr. Herepath's patent system of deodorisation, by means of which the solid matter was to be preserved for agricultural purposes, and the liquid to flow off in an inoffensive and harmless manner.

That method failed entirely. It was too expensive, it did not produce the expected results as to purification, and the manure did not answer. The Local Board, therefore, found themselves in the possession of two large tanks and a channel for carrying off the liquid portion of the sewage, which promised to be useless, and the whole scheme was at a dead-lock. They were in that position when the South Devon Railway Company indicted them for the nuisance caused by their open sewer, which ran parallel with their line for a certain distance and then crossed it, emptying itself at a point down the river just below Countess Weir. To have covered in that long channel would have added immensely to the original cost of the works, and have been a very serious burden to the ratepayers. At that time the merits of McDougall's patent disinfecting fluid, carbolic acid, were much discussed, and it was said to have been used with great success in the sewerage system at Carlisle. The Local Board therefore sent their Surveyor (Mr. Ellis) to Carlisle to inspect the method adopted there.

He found the disinfectant acting satisfactorily, and saw that, with certain modifications, it could be made to apply to the existing machinery at St. Thomas. His report was at once acted upon, and by dint of much ingenuity and contrivance a system was got to work, differing in many respects from that at Carlisle, and a great improvement upon it in point of economy.

The tanks, which were constructed to carry out Herepath's system, were still made available as receptacles for the sewerage of the parish, which was conducted to that point, about a quarter of a mile from the streets, by the same covered main sewer; but within a few feet of the outfall of the tanks the disinfecting apparatus was constructed. This was very simple and economical. It consisted of a common pump, a pail, a vat holding from ten to fifteen gallons, and a little cask of carbolic acid. The pump supplied the pail with water, which was mixed with a small portion of lime, and the lime-water fell by a regulated flow into the vat, into which also the colourless acid from the little cask dripped in the proportion of 1 of acid to 250 of lime-water, forming a brown transparent liquid called carbolate of lime.

In endeavouring to carry on the mixing process on a more economical plan than that adopted at Carlisle, Mr. Ellis met with a difficulty in mixing the lime with the water. The lime had a tendency to remain in the form of a sediment at the bottom of the pail, while the water ran off clear. He, however, after some small experiments, overcame the obstacle by a simple and ingenious contrivance. He pumps the water into the pail by a tube which descends to the bottom of the vessel and forms a coil perforated horizontally towards the centre, and the force with which the water is ejected through the perforations disturbs the sediment of lime (of which only a few lumps are dropped daily into the pail) and keeps the lime and water well mixed. The carbolate of lime formed in this cheap fashion is conveyed, by a small pipe about two feet from the little shed in which the vessels are kept, and drips into the main sewer, which at that point, near the fall into the tank, is furnished with a contrivance similar to a weir, causing a commotion at the fall of the sewage, effectually mixing it with the disinfecting fluid. The two great tanks, which receive now the whole of the sewage of St. Thomas in its disinfected state, are each about twelve feet square, and six feet deep. Their sides are perforated from the bottom to the height of about four feet, letting out the fluid and retaining the solid matter. The fluid is simply dirty water, not at all offensive, and it flows by the same open channel, which was once indicted as a nuisance by the South Devon Railway Company, down to the outlet into the Exe *below* Countess Weir. The sediment in the tanks is removed at short intervals and placed, partly in an adjoining shed and partly in the open air, to dry, and in that form it is sold to farmers, about forty cartloads being taken away every two months.

It is considered to be very efficacious manure, and is purchased by the same farmers who took it in the first instance. The carbolate of lime is said to fix the ammonia, preventing decomposition without rendering the substance insoluble in the soil. A portion of the manuring properties, however, escapes with the liquid that runs away by the open channel to the river, for on a piece of land adjoining the works, watered by this fluid, and consisting of very poor gravel, a remarkably fine crop of beet and turnips is now growing, and the Local Board hope to utilise the liquid manure at some future day by running it upon land adjoining the current of the channel by which it is conveyed to the river.

One man is sufficient to superintend all the operations at these tanks, and the cost of the carbolic acid is not more than 15*l.* per annum. The man in charge also finds time to go round the parish three times a week, and apply the disinfecting fluid wherever he finds any accumulation of impure matter. The fluid is also freely given away to the poor, who frequently avail themselves of the privilege to purify their dwellings, especially during the prevalence of epidemics.

The complaint which the St. Thomas's Local Board have, from time to time, made to the authorities of the City, refers to the state of the river immediately below the Exe Bridge, upon the St. Thomas side. '*The whole sewerage of Exeter is emptied into the river*, a large portion of it being received into the mill-leat, which runs between Commercial Road and the Exe; and the allegation is that at the particular point of the river in question, where the water is almost stagnant from being out of the current, there is an accumulation of impure matter washed and floated there by the eddy. To this complaint there was, no doubt, for a time a good reply; for the sewerage system of St. Thomas was not complete. About 120 houses on the north side of Alphington Street and Okehampton Street still continued to be drained into the Exe, and the city authorities charged the people of St. Thomas with themselves causing the nuisance of which they complained. The Local Board of that parish, therefore, resolved to remove that evil, and, at considerable cost, they laid intercepting sewers down Alphington Street and Okehampton Street; and now having *stopped every house in the parish from emptying its sewage into the river*, they turn to the Exeter Local Board, and say, 'We no longer pollute the stream, but yet it is as bad as ever.'

The water and the bed of the river are certainly in a very unwholesome state along the shore next the south-east corner of the bridge, and the place is only kept from emitting a foul stench by the application, two or three times a week, of the disinfectant. The inhabitants at that spot complain loudly of the foul state of the river; and at the workshops adjoining, it is said they are compelled to keep the windows closed at times, and the men are often ill from the effects of the impurity.

The plan suggested by the St. Thomas Local Board is to build a low wall and reclaim the piece of land where this stagnation takes place; and it is said that persons in the neighbourhood would be willing to pay the cost for the sake of a lease of the reclamation. On the other hand, it is contended that to narrow the stream at that point would throw too much swell on the opposite point, and the authorities of the city still allege that the nuisance is caused by the inhabitants of the St. Thomas's side. The question has been referred to the Streets Committee and the Surveyor to the Exeter Local Board; but we understand that it is not proposed to take steps for the permanent alteration of the river as suggested by the St. Thomas's Local Board.

That parish has, however, now placed itself in such a position that, if the foulness is not permanently remedied, they will be able to charge the city authorities with causing the nuisance.

While the Local Board of St. Thomas were engaged with much determination and good sense in relieving themselves of the great and serious difficulties connected with the sewage question, another trouble arose. They had been supplied with water by the Exeter Water Company constantly for sixteen hours every day; but when the agreement ran out a few months ago, the Company, in accordance with a previous notice, declined to furnish any longer a continuous supply. They gave, some months before, an intimation that for the future all houses to be furnished with their water must be fitted with cisterns to be filled only on certain days in the week, on the peculiarly objectionable and unsatisfactory plan of the water supplying the city. The Local Board of Health spiritedly refused to accede to that proposal. The stinted supply of water was calculated to upset all their plans for promoting the health of the parish, and in particular it would tend to interfere with the working of their sewerage system. Much discussion ensued, deputations waited upon the Water Company. The Local Board sought to make compromises, offering to be content with ten hours' and even eight hours' supply per day; but the Company would not yield, and the inhabitants unanimously supported the Board in their determination not to accept the Company's terms. The result is that the Board have decided to erect waterworks and supply the parish; and, with characteristic promptitude, they have already sunk a huge well, in a field near the Okehampton Road, into which pure water, filtered through the earth, flows in abundance at the rate of 100,000 gallons in 24 hours. The well is 12 feet in diameter, and will be made 20 feet deep. From this the water will be pumped to a reservoir from which the whole parish will be supplied constantly.

(This has since been carried out, and is still in active use with a fair supply.)

From these specimens of the courage and public spirit of the St.

Thomas's Local Board, it would seem that the parish deserves the respect and consideration of her elder sister on this side of the river, and such complaints as she makes have a claim upon the attention of the authorities of the city. The parish of St. Thomas is poor and contains a large number of inhabitants, and the credit due to them is so much the greater for what has been done for the health and comfort of the population.

The Local Board, under the excellent chairmanship of Mr. Pince, have watched over the interests of the parish with such zeal and method during the last few years that fevers and epidemics are almost unknown. With a good water supply and an efficient sewerage system, more than half the conditions necessary for health, even under unfavourable circumstances, are secured. The sewerage question is still in an unsettled state, and, except in places like London, where the emergency is very great, it is not wise to enter upon works of great cost and magnitude; but until scientific and practical men have decided upon a really effectual method of preserving at once the health of the people and the whole fertilising properties of the manure, we know no plan so well calculated as that adopted at St. Thomas to give safety to the public at so trifling an expense, with the least loss to agriculture and breathing time to the philosophers.

For the last twenty years the Local Board of St. Thomas has used carbolic acid as a disinfectant, and this paper has already treated of the first seven years of that period, during which negotiations were opened with the authorities of the adjoining city of Exeter, committees were appointed, deputations 'waited,' and every effort was made to secure their co-operation. This state of things continued for some time, but finally fell through, and the city continues to this day to pour all its sewage and waste water into the River Exe, which thus becomes a *gigantic cesspool*, the *slush* being kept from flowing away by a series of weirs.

The remaining thirteen years of the twenty have now to be accounted for. During this period the number of houses has been steadily increasing, and we have found our system as good as ever; we have added to the number of tanks as our need has increased, and during the last twelve months we have considerably obviated a difficulty we before experienced in saponifying, or rendering sufficiently miscible, the carbolic acid, which from its oily nature had a strong tendency to float in considerable quantity on the surface of the fluid in the catch-pits, thus causing a waste of the disinfectant, and occasionally impairing its efficiency.

The addition is both simple and inexpensive, and its quantity too insignificant when compared with the bulk of the sewage to influence its quality to any great extent. It is the simple addition of a little common salt to the lime with which the carbolic acid is blended.

We find the daily allowance which is sufficient for all ordinary occasions costs about 1*s*. 3*d*., and consists of

		d.
35 lbs. of white lime	. . say	4½
12 lbs. of common salt	. . "	1½
3 pts. of carbolic acid	. . "	9

These are thoroughly mixed together in a suitable vessel with water; this is conveyed in a carefully graduated stream into the main sewer at a point a short distance from its opening into the catch-pit, and is so regulated as to continue flowing for the twenty-four hours.

The population of the district sewered is about 4,500.

The sewering is divided into two sections, the older portion of the parish consisting of 3,687 yards of glazed piping from 9 to 18 inches in diameter, with an ordinary delivery of 314 cubic feet, or 1,965 gallons per minute. The newer portion of the parish is sewered with 2,533 yards of glazed piping from 9 to 15 inches in diameter, with an ordinary delivery of 157 cubic feet or 981 gallons per minute, without storm water. The average inclination is about 1 in 450.

Our present chairman, Mr. Mark Farrant, is also fortunately our medical officer of health, thus enabling us to keep pace with the health requirements of the district in our sanitary work, and keeping us informed of many important details which would probably otherwise be never brought under our notice. We have an excellent surveyor, Mr. Samuel Churchward, appointed in February 1874, and who has since that time been most energetic in carrying out the great work of sanitation.

The health of the district has been steadily improving, and we have every reason to be satisfied with the present system as far as we have carried it.

Our low-lying level prevents our filtering the sewage as effectually as it might be done in a different situation, and we have hesitated at incurring the expense of another engine in the parish, which, if placed at our sewage works, would get us over all our difficulties in the way of raising the bulk of the sewage to a higher level, and enable us to filter thoroughly the solid portion, as well as, if required, to distribute the fluid which contains so many valuable fertilising salts in solution. We have already done much good work in our parish, and must for a time be content to rest from our labours and await the course of events and the further development of science, always bearing in mind that much wealth is being daily lost to our country from the want of knowing how to utilise those products which both nature and common sense teach us are the true and only source of agricultural prosperity.

William Robert Woodman, M.D.,

Ford House (St. Thomas), Exeter,
Member of the Local Board of
Health of St. Thomas.

Mr. Chadwick, on the incidental question of disinfection, said that the subject had been very carefully examined in Paris, Berlin, and other places, and the unanimous conclusion was that the cheapest, best, and most effectual way was the direct application of the sewage to the land, without any intervention whatever. At Croydon, as Dr. Carpenter could testify, it was effectual, provided it was done in a proper manner. There was a distinction not yet understood—that between fresh and putrid sewage. What was smelt in towns was putrid sewage. The direct application of fresh sewage was the least expensive and most efficient system, and the one that should be adopted.

In reply to the President, Dr. Woodman said he himself used the sewage on his farm, paying by tender 15*l.* a year for it.

The President said it must be quite clear that, as a profitable speculation, it did not pay the parish of St. Thomas to utilise the sewage; and it was curious that they should go to Carlisle for an example, when at Carlisle Mr. McDougall never did anything of the kind that Dr. Woodman had been speaking of. Mr. McDougall never made a profitable manure; he was not aware that Mr. McDougall ever made 1*l.* by any portion of the solid matter. He supposed that there was no complaint at St. Thomas because the sewage went into a very large body of water, itself impure from other sources. If they wanted to get the greatest amount out of the sewage they must not disinfect the crude sewage at all. It was not in every town that they could find land on which to pump the sewage. But at Doncaster and Leamington, from Christmas to Christmas, the crude sewage was pumped on to the land, and it produced very good crops when the season permitted it. He would say advisedly to the Exeter authorities that it was the duty of the Municipality to get rid of the sewage in the cheapest way; but if it cost a rate in aid, it was the duty of the Municipality to do it, and pay without grumbling. A gentleman present had taken a poetical license when he said that the sewage of Glasgow could be pumped over the mountain tops. No local authority was justified in paying 30*s.* for a sovereign.

Mr. Boulnois said that of course there were two sides to every question, and the works just described had somewhat of a notoriety, not from their immense size, for they heard that they only professed to treat with the sewage of 4,500 persons, but from the fact that they were sometimes complained of as a nuisance. Persons who travelled on the South Devon Railway were often made painfully aware of their proximity to the spot where the refuse of St. Thomas was emptied out. The process adopted at St. Thomas was similar to that of Taunton, but at the latter place they found it necessary to mix the carbolic acid, lime, and salt together by machinery, and also to mix this compound with the sewage in a similar manner. At St. Thomas one old man was found to be sufficient, and, he believed he had also many other duties to perform. The effluent water from these works was allowed to enter a brook in the neighbourhood, and it was not quite so clean and free from impurities as would be considered to come up to the standard of the Rivers' Pollution Act. (A bottle of the effluent water was produced by the speaker, and looked very like thick ale.) Dr. Woodman's paper seemed to him to be almost an attack upon Exeter; and the introduction of the subject of the water-supply of St. Thomas, which surely could have nothing to do with the treatment of sewage, strengthened his suspicions, now, with reference to the water-supply. It was an absolute fact that at this present moment there were many persons who declined to take the magnificent supply offered them by the St. Thomas Local Board, but preferred to take the Exeter water. He would not then tell them of the excellent quality of the Exeter water—as that subject was reserved for discussion; but he wished to disclaim entirely a misrepresentation in the paper just read, to the effect that St. Thomas was not supplied with water by Exeter. It was supplied to many customers who paid for it; and, he regretted to say, also to many customers who were so infinitely fond of it in preference to the St. Thomas supply that they stole it. Nor could they wonder when they heard in the paper just read of wells 20 feet deep, supplying 100,000 gallons per diem; and that the wells were sunk in a gravelly soil, close to the fearfully polluted River Exe, to which their attention had just been drawn. It would be observed that Dr. Woodman produced no analysis of the water so bountifully bestowed on the inhabitants of St. Thomas. He did not wish to deny that the whole of the sewage of Exeter did reach the river, but it must be remembered that within a mile of Exeter the river became tidal. The Town Council had not been idle either. Four years ago, just after his appointment as their Surveyor, he presented them with a report on the sewerage question, and laid a scheme before them for disposing of the sewage, by carrying it in pipes along the raised banks of the Ship Canal, and irrigating some 700 acres with it at will on both sides. This plan was to cost 30,000*l*. Last year he presented them with another report, proposing to deal with the sewage on some fields known as Duck's Marsh. A plan of this was hung in the Exhibition in connection with the Congress. The cost of this scheme would have been 13,000*l*, exclusive of land or compensation. Exeter, he believed, was quite willing to do that which was expedient when the right time came, but he regretted to be compelled to state that it would not be to the St. Thomas sewerage works that they would turn for a lesson. In many of these precipitation sewerage works the addition of the precipitant or disinfectant was intermittent, and often only added when an inspection was expected. He should not be surprised if the St. Thomas works were no exception to this rule. His duties as engineer often took him to the Ship Canal and along its banks, and he was often struck with the sights and smells of the stream into which the effluent flowed, some two or more miles below the works, where it joined another brook, and passing under the Canal, reached the tidal portion of the river.

Mr. Bodley asserted that the depth of the wells in St. Thomas was 30 feet, not 20 feet.

Mr. Sillar demonstrated that at Aylesbury sewage was deodorised by the A B C process without its fertilising powers being destroyed.

Mr. J. Daw observed that at Trew's Weir the water was impounded, and thrown back upon fifty acres of land.

Dr. Woodman desired to revert to Mr. McDougall's operations at Carlisle.

The President said that when Mr. McDougall's lease was out it was not renewed; and now the inhabitants, having an injunction filed against them, were devising means to get rid of the sewage without polluting the river Eden. In point of fact, Mr. McDougall worked his process at Carlisle to enable him to bring into notice his carbolic acid, and for no other beneficial purpose whatever.

Dr. Woodman, in his reply, said that in some places both banks of the Exe belonged to St. Thomas, and its inhabitants did not like to see the river polluted by the sewage of Exeter. The 'effluent' produced by Mr. Boulnois was not drinking water; but the decanter of fluid on the President's table was represented to be Exeter drinking water. His object was to prevent the pouring of sewage into the river by the Exeter people.

The President added that the Public Health Act prohibited anyone from discharging crude sewage into the river. It only required some person to put the law in motion, and an injunction might be obtained to restrain this action by the towns on the Exe.

Sewer Gas Annihilation.

The author of this paper has recently published a pamphlet on the subject of the ventilation of sewers, in which he has described in detail the several methods which have been introduced for the purpose of disposing of the noxious gases generated in sewers and drains. He will not therefore recapitulate these systems, but will content himself with a few observations on the 'open shaft' ventilation system, which has hitherto found most favour with sanitary engineers and others who have dealt with this all-important question.

It is unnecessary to describe all the various forms of the 'open shaft' system, as they are probably well known to most of the hearers of this paper; and whether open gratings in the centres of the streets are employed, or shafts carried up the sides of buildings, or the gully-pits left untrapped, they are one and all modifications of the same principle, which is to allow the escape of the foul gases of a sewer into the neighbouring atmosphere.

Now let us as sanitary exponents ask ourselves at once, is this a truly sanitary and wholesome measure; to allow these offensive and perhaps pestilential gases, which are generated in our public sewers, to pass into the air we breathe, and thus to pollute and poison it?

Is the principle a scientific one? Has any advancement been made over the old systems, when open ditches and brooks received the contents of the house-drains and of the sewers; when, be it remembered, such brooks and ditches had these advantages over our present well-constructed sewers: the surrounding earth deodorised and absorbed a portion of the sewage, and the whole length of the ditch being open, the foul gases that were generated did not concentrate at any one point, as at a ventilating shaft in the present system. And again, no doubt the banks of the brooks and ditches were fringed with a luxurious growth of watercresses or other aquatic plants, which helped to destroy many of the offensive components of the sewage flowing past, and it was only when the sewage overpowered nature, and the senses of sight and smell were overcome, that our predecessors, in order to avoid these evils, covered over the ditches and brooks, and in some cases gave them paved inverts. Foul gases, however, of sewage decomposition were still rapidly formed, and the advocates of open ventilation at once said: 'We find these gases are generated, however well our sewers are constructed, and however quickly their contents are made to flow, and we further find that unless we allow these gases to pass out readily through openings into the surrounding atmosphere, that they pass through the house-drains, into the confined spaces of the dwelling-houses, and poison the inhabitants.' It is also contended that open ventilation introduces fresh air into the sewers, and that by so doing the foul gases are disseminated and destroyed, and are so diluted as to be rendered quite harmless.

These arguments are perfectly true and consistent, and it is without doubt absolutely necessary that these dangerous and offensive gases should be kept out of the interior of our dwelling-houses. But the author goes even farther than this, and says that this impure gas should not only be kept out of our dwelling-houses, but that it should be kept out entirely from the air we breathe, and not be suffered to pollute the atmosphere of our crowded courts and narrow streets, nor be breathed in its concentrated form by persons unsuspectingly passing by or standing over a ventilating grating or shaft.

And with respect to the introduction of fresh air into the sewers, although the author does not wish to absolutely condemn this practice, he wishes to point out the scientific fact that the action of the atmospheric air upon the organic matter contained in the sewage, produces and feeds decomposition or putrefaction, and that if it were practicable to make a sewer perfectly airtight, or in other words to hermetically seal it, no decomposition could take place.

In practice, however, this would be found to be impracticable, and sewers unprovided with any outlets or safety valves for the escape of the vapour or gas generated in them are frequently found to be dangerous to the locality in which they are situated, and so it has come to pass that open sewer ventilation has been introduced, and that up to the present time no better means for the disposal of the foul gases have been discovered.

It is true that the charcoal tray or basket system was introduced some years ago. The author will not waste time by describing this system, as it is so well known, but will content himself by observing that it has not found much favour with engineers; for, irrespective of its first cost, admirable as the system is, it is found in practice to be rather complicated, and the charcoal is apt to clog and become inoperative after a short time by reason of the wet affecting it and the vibration of the traffic. It is consequently necessary to give it a great deal of attention, and the first cost is not the only one involved. It was therefore with a view to discover some other simple, inexpensive, and certain method to deal with this vexed question of sewer ventilation that the author gave the subject some considerable attention, and in the course of making some investigations on the subject, he found that in some of the old ill-constructed sewers he inspected that there was a remarkable absence of smell or foul gas, although from the conformation of the sewer the contrary might have been expected.

On searching for the cause of this, the author noticed that the brickwork of which the sides and crown of the sewer were composed was very defective, and that holes and openings were thus caused through which the air in the sewer passed and became absorbed in the surrounding and superincumbent soil.

The outcome of these observations and investigations has been the invention by the author of what he has designated the 'sewer gas annihilator,' the principle of which is based on the well-known fact that earth has a powerful action in deodorising and rendering innocuous fæcal and other matters undergoing decomposition, and in absorbing the noxious gases and emanations from such matters.

There are of course many modifications of this principle, but the author will proceed to describe a few of the best methods, which he has patented.

For a brick sewer where no spring or subsoil water is present, a perforated earthenware segment is built at intervals in the crown of the sewer. In a pipe sewer a portion of the upper periphery is perforated in a similar manner. These perforations in each case are surrounded by broken stones, then gravel, and lastly dry earth, the whole being built up with sloping sides, and isolated if thought necessary from the surrounding ground by either panning the sides, or coating them with fine concrete or asphalte.

Where any manhole or ventilating or lamp shafts already exist, they can be treated in the following manner, or, in their absence, shafts can be specially built. These are covered with a perforated cover or hood of various shapes, which are then surrounded by broken stones, gravel, and earth as before, which are then placed in the form of an inverted cone and are isolated as in the previous case.

The diagrams accompanying this paper show the arrangements alluded to, which are extremely simple, very easily constructed, and kept in working order by the most unskilful workman, the expense of their construction being almost nominal: and the author will now proceed to point out some of the advantages of the system which he advocates:—

Sewer gas, or 'fœtid sewer organic vapour,' is frequently generated in the sewers of the best and most modern construction, partly on account of temporary obstructions in the sewer, partly because of the so-called low and high watermark in a sewer, which allows an accumulation of slime, and is constantly manufacturing the gases of decomposition.

Now these gases of decomposition have over and over again been proved to be highly poisonous and even dangerous to human life, and although it is affirmed that, diluted with atmospheric air they become harmless, the author does not recollect that such has ever been proved to be the case. On the contrary, it has been shown more than once that this sewer vapour contains solid flakes or atoms of organic matter floating about in it, and also contains germs of disease which all the atmospheric air surrounding our globe is powerless to destroy. Woe betide any unfortunate child or adult into whose body these germs are carried by the air wafted from an open sewer ventilator, often the chosen favourite play place for the children from the adjacent Board School, who should have been at all events warned against the danger thus incurred, however little else of sanitary or practical knowledge they may have been taught.

In the author's system none of this deadly poison is allowed to escape into the air we breathe. It is on the contrary 'cabined, cribbed, confined;' it is absorbed into the earth and there rendered harmless and safe by nature's own great laboratory, and the sewer which is so carefully buried out of our sight in the ground beneath us, is really, *not* nominally, separated and cut off from our daily life.

The intermittent flow of the sewage constitutes the force which, slowly but firmly, forces the foul air through the apertures over the stones and gravel into the earth.

Experiment and observations only can prove what area of earth is necessary in any sewer to overcome the gas, as this must vary in every town in England, and almost in every street; but there is no difficulty and but little expense to be incurred in expanding this area to any reasonable and required limits, and should the earth forming the annihilator become overcharged and sodden with the gases it has absorbed, it can easily be removed, sold as a valuable manure at a large profit, and fresh earth substituted. In fact, this is an application of the principles of the dry earth system for the disposal of sewage to the water carriage system, which has hitherto been found the most convenient, clean and inexpensive :—water to carry off the refuse of our houses, earth to disinfect the impure gases, and to prevent the air we breathe from being poisoned.

Some hearers may argue that the earth composing an 'annihilator' might be washed or find its way into the sewer below, and thus cause an obstruction in it, besides injuring the good effects of the 'annihilator.' But this could easily be prevented were even such a contingency likely to occur, for in no case need the 'annihilator' be placed at a less depth than 12 inches from the surface of the ground, and in ordinary soil the rain seldom reaches such a depth. Besides this, the annihilators would in nearly all cases be placed under roadways or streets, the surface of which, if even composed of macadam only, would effectually prevent any washing taking place.

In completely closing up a sewer in the manner suggested by the author, and in doing away with all open communication with the external air, there is of course the risk to be run of unsealing the traps of the street gully gratings or of house-drains, when the air contained in a sewer is put under an abnormal pressure by reason of its liquid contents being suddenly largely increased by a heavy rainfall or by an artificial flush of water.

It is however a fact, that there are many cities and towns in England where no provision whatever is made in the sewers for the escape of the air when under such pressure, and, so far as the author is aware, no evil results have followed in consequence.

In the system which he advocates, he is of opinion that the ordinary rise of the level of the sewage in a sewer, and consequent increase of pressure in the air therein, will certainly not be sufficient to unseal either an ordinary 'mason's' or 'syphon' trap, but that the effect will be simply to compress the air (which is well known to be extremely elastic) into a smaller space, and to force it more rapidly into its 'annihilator,' which acting like a sponge, will absorb and cleanse the air thus driven into it, the latter returning when the pressure is withdrawn, purified by its contact with the earth.

In the case of a heavy fall of rain extending over a short period of time, when the sewers and drains of a town are running full almost to bursting point, the effect no doubt will be to unseal all the traps of the gully gratings and thus liberate the air. This result will not be concentrated at any one point. It will be scattered all over the city, and the sudden liberations, or almost explosions of the air through the traps, will be intermittent and at varying times. In fact, it would be merely a transfer of outlet for the air, which outlet at present is the grating in the centre of the street or the shaft at the side of the house; in the author's system it is the gully grating at the side of the road. The effect would not be noticeable, and when the storm was over, the gully pits could be cleared of the detritus with which most of them would be filled by the sudden storm, the exceptional derangement of the system would be rectified, and all would again be well perhaps for many years.

With regard to the house-drains, and the possibility under these exceptional pressures of the sewer gas being driven into the dwelling houses through them, the author is of opinion that all house-drains should be pneumatically separated from the main sewers, so that under no circumstances whatever could the air from a public or main sewer find its way into a dwelling house.

Of course, to effect this would be enormously costly to any community. As the system is not now in use, and in fact, on the contrary, many of our houses are in direct untrapped communication with the sewers, the author is of opinion that his system is superior to the open shaft system, for the reasons he has given, and also from the fact that, except in cases of heavy and unnatural rainfall, the pressure of air in the sewer would not be subject to the variations now effected in it by the external air being often blown, sometimes fiercely, *down* an open-air shaft, unsealing all the traps in the vicinity, and forcing the foul gases into the houses.

The author has not at present been able to give his system a full trial, but he has been able to give it a rough test, with very satisfactory results. A few years ago, acting under instructions from the Town Council of Exeter, he constructed about $1\frac{1}{3}$ miles of stoneware socket-pipe sewers, in a district of Exeter known as St. Leonards. These drainage works were constructed on the approved method of straight lengths with circular manholes at every change of direction or gradient. As open ventilation by means of grids in the centre of the roads was objected to, these manholes were each covered by a solid cast-iron plate, placed about 12 inches below the surface of the ground. After the drainage works were completed and the contract finished, the roads throughout the district were reformed and reconstructed under the directions of the author; and it was then found necessary to raise these manholes, in order to bring their tops to within a convenient distance of the surface of the roadway.

Previous to this, many complaints had reached the author of the bad smells arising from the gully gratings in the neighbourhood of the new sewage works, which, on investigation, were found to be correct, and they were temporarily rectified.

When the manholes were raised, the author treated them in the following manner: he caused every other radial brick in the upper course of the brickwork to be omitted, the plate replaced, and the ground made good; the cost of this being less actually, on account of the saving of bricks, cement, and labour, than it would have been had the brickwork been constructed solid as before.

These manholes thus became rough and ready 'annihilators'; and, as a proof of their beneficial results, no complaints of smells from the gully gratings in their vicinity have ever since been made—although the summer having been exceptionally dry they were frequently, and for long periods, perfectly free from water, and were consequently unsealed.

This, therefore, has been as thorough a trial as could be made under the circumstances, and has proved entirely satisfactory.

If, however, the author had had sufficient time at his disposal to have carried out his system in its entirety, he would have been quite able to refute any objections that could be raised, and he would also have been able to lay before you some more scientific and elaborated evidence of the beneficial results that he confidently believes will follow the adoption of his system.

H. Percy Boulnois, M.Inst.C.E.,
City Surveyor of Exeter.

Mr. Chadwick said, as the writer of the paper asserted that, however well sewers were constructed, gases would arise, he could not have visited towns where that phenomenon did not take place. At Croydon, some of the drain-pipes were only connected with clay, which disappeared, and the nuisance occurred, but elsewhere in the town where the sewers had been properly made, there had been no disease arising from this evil. At Carlisle, so well sewered by Mr. Rawlinson, there had been an escape of sewer gas, and fever; but this arose from the ill-construction of a section of the sewerage. At Carlisle the fault was that the putrid sewage and gases remained in a portion of the sewers for a year or more. There ought to be no smell, and there would not be if there were self-cleansing house-drains, and if the sewerage were properly constructed.

Mr. Robins said that the difficulty in Mr. Boulnois's plan would be to get the air to pass through such solid substances. There might be furnaces at the end of some of the long sewers, in combination with Mr. Eassie's plan of cremation.

The President could not encourage Mr. Boulnois to continue his experiment. He would not himself adopt it, and could not advise others to do so. If there was a bad smell, it was because the drains were closed. It was of the utmost importance that the sewage gas should go into the open air rather than into the dwelling-houses. It might be offensive if it came into the street, but it was infinitely better in the street than within the four walls of a dwelling. He could not regard Mr. Boulnois's plan with the slightest degree of satisfaction. If we stopped the ventilation of a sewer, we should soon have the whole population down with typhoid.

Mr. Square (Plymouth) believed it would be an advantage if all the street gullies were untrapped.

Mr. Boulnois, replying upon the discussion, said that as his plan was a novelty, he expected to meet with opposition just as the President had met with opposition from the Institution of Engineers, when he first suggested small-sized sewers on the Memphis model.

Suggestions for the Cleansing of Sewers.

The water-carriage system, with its many and great advantages, exposes a community employing it to serious dangers. These arise, in most cases from preventable causes; but as ignorance, apathy, and the scamping of work cannot be completely eradicated from human beings, it behoves those who may suffer from the consequences of these shortcomings to take all possible precautions against them. If the sewage of a town could at once and completely be removed from the neighbourhood, and be taken to a point sufficiently distant, its inhabitants might escape harmless, whatever might be the annoyance to its neighbours between them and the sea: but this is not often the case. When Dr. Johnson threw the snails from his own garden into that of his next door neighbour, the relief was, probably, temporary only. They increased and multiplied in their new resting-place, and without doubt many of their offspring found their way back again to the garden of the great philosopher. So also, whilst we are passing our sewage on to the next parish, enough of it lodges on the bottom of the sewers to produce by its putrefaction the germs of those diseases which so often ravage our towns. We might say, indeed, of a particle of sewage which we cast into a badly constructed sewer, 'Then goeth he, and taketh to him seven other spirits more wicked than himself, and returns to the house whence he set out, and the last state of that house is worse even than the first.' It was better off when it emptied its uncleanness into a cesspool. Sewage matters, when mixed with water, undergo rapid decomposition, and being of a slimy, glutinous nature, adhere tenaciously even to the comparatively smooth surfaces of drain pipes, and much more so to the porous surfaces of bricks; and when to this cause of uncleanliness in drains and sewers is added the evils too common in every town, of '*main drains which, from ignorant construction as to the levels, do not perform their office, and do accumulate pestilential refuse; and others which have proper levels, but from the want of proper supplies of water do not act,*' we can hardly be surprised that our noses are often offended when passing sewer gratings in the streets, or, if we have not broken the uninterrupted communication between our house drains and the street sewer, that our families are visited by typhoid and diphtheria.

Too often 'each drain acts' (as was stated in the First Report of the Commissioners for Improving the Health of Towns, from which the above extracts are made) 'like the neck of a large retort, and serves to introduce into the houses the subtle gas which spreads disease from the accumulation in the sewers.' The well-directed labours of Mr. Field, Mr. Griffith, and others are effecting much to prevent this in the houses of the wealthy, but without special administrative arrangements no relief will be given to the classes who cannot afford to employ a skilful engineer, and, indeed, cannot perceive the paramount importance of doing so.

The expedients which can be adopted to remedy the evils arising from the adhesive nature of sewage matters and from their deposition in flat drains, or arising from an insufficient quantity of water, are first to break up the slimy, glutinous condition of the sewage as soon as possible; secondly, to absorb the gases which arise from the decomposition of the sewage, and which, by the increased pressure, exerted by them, force sewage gas into our streets and houses; and thirdly, to flush the sewers copiously.

The two first objects can be attained by introducing lime into the sewers at their summit levels. The gases which chiefly result from the decomposition of the organic matters of the sewage are carbonic acid and sulphuretted hydrogen, the first being evolved in by far the largest quantity. When lime is introduced into sewage-water, the carbonic acid is removed from solution, and can no longer add to the pressure of the air in the sewers. The sulphuretted hydrogen is also for the time rendered comparatively inoffensive, being converted into sulphide of calcium. At the same time the glutinous nature of the sewage is destroyed by the coagulation produced, and then, with a degree of flushing, proportional to the flatness of the sewers, all deposits can be readily removed. The sewage no longer acts as a cement to bind together the particles of detritus washed from the roads.

In the year 1872, I had the opportunity of carrying out an experiment at Ealing, which I find described in an old paper of mine in the following words:—

'*In lieu of introducing the precipitating materials at the outfall, as hitherto practised, they have been introduced into the sewer itself at a point nearly* $1\frac{1}{2}$ *miles from the depositing tank, and near the head of the village . . . and the experiment was attended with the happiest results. All the slimy and sticky, black decomposing filth which usually furs the bottom and sides of drains disappeared; the main sewer was perfectly freed from stinking sewer gases, no deposit of any sort was left behind, and, owing to the thorough admixture of the chemicals with the sewage, the deodorisation and precipitation were more perfect than when the precipitants were introduced at the outfall. As the main sewer alone was treated, and the branch drains to the side streets and houses were comparatively unaffected, still, inasmuch as the great volume of the sewer gases was disposed of, much benefit resulted.*

The Surveyor of Ealing, Mr. Charles Jones, visited a portion of the sewers with my brother, and found the results above described; and so much impressed is Mr. Jones with the value of the cleansing effect of the lime on the sewers, and of having the liming operation under his own eye, that he has prepared a chamber within the premises of the Local Board from which the lime can be introduced at the head of the main sewer.

It may be objected, perhaps, the the action of the lime would also be to set free the ammonia, and as this is a great carrier of noxious vapours, a counterbalancing evil to the advantages named might be reckoned upon; but I submit that the quantity of ammoniacal salts existing in the sewage is too minute to allow appreciable volumes to escape from the liquid, more especially as I would propose to add the lime at the moment when the flushings take place, and so contrive the flushings, by means of the sewage water itself, that they may take place at short intervals of time. In so far as the solid organic matter is concerned, as long as any free lime is mingled with it, putrefactive decomposition does not go on, and when the lime becomes carbonated it loses the property of expelling ammonia from liquids. By the use of salts of iron with the lime the sulphuretted hydrogen may be permanently, instead of temporarily, fixed, but the cost of the process is increased. Lime is recommended on account of its small cost, but many other precipitants will serve the purpose. These, then, are the means which I would suggest for deodorising the sewage, for reducing the tendency of the gases formed from it to escape into our streets and houses, and to enable the deposit to be washed from the bottom and sides of the sewers with facility.

For flushing purposes I would suggest the use of the beautiful invention of our colleague Mr. Rogers Field, which is exhibited by Messrs. Bowes Scott and Read at the Exhibition now being held at the new Abattoirs in this city. The flushing tank of Mr. Field allows of the sewage itself being employed to work it, so that the process of washing out the sewers can be effected without material cost. It also admits of the use of power obtained from the falling water from the tank to discharge from a hopper the required doses of quick lime. Of course, when lime is applied at the summit levels of the different branches of a sewerage system, precipitation at the outfall tanks may be dispensed with.

H. Y. D. Scott, Maj.-Gen., C.B., F.R.S.

Sewage.

In former days, when population was less dense, and towns depended upon wells and rain-water butts, before a regular water-supply had been introduced, cesspools and drains satisfied the requirements of the inhabitants for the storage and removal of foul liquids, as well as surface and subsoil water; but when once a regular water-supply introduced water-closets and a generally increased consumption of water in a town, there arose an imperious demand for better sewerage or drainage.

Engineers who had scientifically planned and constructed a water-supply system, with pipes carefully graduated to meet the wants of every street and house, seem to have exhausted all their science and energy in the effort to provide the water, and when called upon to secure its removal, after it had been fouled by use in the town, they could think of nothing better than to let it soak away into subsoil, or run downhill in old or new drains together with the rain-water. When the need of sewerage was first recognised, it was thought that settlement in a tank before discharge into the nearest natural watercourse was all that was necessary, and accordingly the sewerage system was contrived to bring everything—sewage, rainfall, and all—to some low-level tank outside the town, and as close as possible to the natural watercourse.

Science seems to have departed directly the water was let loose from its supply-pipes, and, although every engineer's pocket-book bristled with formulæ and tables showing the volume and velocity of water running through pipes of given diameter and gradient when full or half-full, &c.—in practice it was considered that cost was the only limiting consideration, and that the larger the pipe the better the sewer.

Millions of money have been expended upon no better system than this haphazard one, and when our rivers became foul, and chemists began to calculate the theoretical value of excreta per head of population, inventors crowded in to discover short cuts for the recovery of the manurial matter which was being thus unscientifically cast away.

Success, however, is rarely reached by short cuts, or by acquiescence in the neglect of natural laws, and most of these inventors have at last found their level after years of not very honest toil, seeing that they always vaunted their success in purifying the sewage of a town of such and such a population without referring to the fact that, whenever rain fell upon the sewered area, a volume of foul liquid, ranging from double to ten times that which they professed to purify, was always suffered to escape by 'storm-water overflows' without treatment of any kind.

The great Duke of Wellington, commenting on the want of practice in the movement of large bodies of troops within the reach of officers in his latter days, is said to have remarked that if an army of 50,000 men was assembled in Hyde Park, there were not two generals who could move it out again without getting the men mixed up with the London rabble, which would destroy its efficiency as an army. And this is exactly what our civil engineers have done with regard to the water-supply of nearly every town in Europe and America, *i.e.* they have brought it scientifically into the town and left it to find its own way out, mixed up with a variable quantity of rain-water, which destroys its value as sewage.

Nor is this loss of value the only bad result of such a want of system, for in a sanitary point of view the large sewer must in dry weather generally become a gas-generating cesspool, instead of the self-cleansing conduit always contended for by Mr. Chadwick, Mr. Rawlinson, and the other prime movers in the demand for better sewerage from the year 1848 up to the present time.

These great men pointed out the need of such self-cleansing sewers, but the executive engineers thought that the rain-water of our humid climate would cover any want of calculation and consideration which it was inconvenient to them to apply to their work, so they made every sewer as large as they could, and trusted to Providence.

At a meeting of the Society of Arts in the year 1876, I referred to this arrest of scientific treatment at the point when water issues from the supply pipes, and the idea was taken up and has been fully and satisfactorily worked out by Mr. Isaac Shone, a mining and civil engineer of Wrexham, who read a Paper at the Annual Congress of this Institute at Leamington in 1878. I then remarked that probably, in future years, that meeting would be especially noted for its introduction of the sewerage system of the future, and after two years' observation and experience of its excellence, I agree with the following quotation from a letter lately received from Mr. J. J. Mechi of Tiptree Hall, Essex, who says: 'Nothing can change my conviction of the practical utility of Mr. Shone's admirable and simple invention, and I feel sure that, ultimately, it must be generally adopted.'

At the time of writing this paper I have no pecuniary interest whatever in Mr. Shone's patents, and it would doubtless be more prudent for me to stand by, as so many other engineers are doing, to see whether the inventor will sink or swim by his own exertions to get a town to try his system. That is really the point, as all who have studied the question admit, *que ce n'est que le premier pas qui coûte*, and if one town or a part of it once experienced the sanitary and economical advantages which the adoption of this system would secure to it, the revolution in sanitary engineering would be accomplished. But as a member of the Council of the Sanitary Institute of Great Britain, I desire to contribute my mite to the common stock of knowledge in sanitary matters which it is the mission of this institution to collect and proclaim.

The system in question has been before the world for two years, and has met only with praise from those who have studied it. Among that number not an objection has been made which could not be readily answered. I will not weary the meeting by entering into details which are to be found in numerous circulars and pamphlets supplied by Mr. Shone, but should like to state that I am fully satisfied with the trial which has been made at my farm during the last year and a half, not, be it understood, for any purpose or advantage of mine in irrigating the land, but simply as an exhibition to numerous visitors of the inventor's method of lifting liquid from a low to a high level by the power of a steam engine, or water power, at long distances from the point at which the lift is required.

Now every engineer who has ever planned the sewerage of a town must recognise the advantage accruing from the facility of giving good falls to the collecting sewers towards certain man-holes under the streets, wherein, by a simple automatic apparatus, their contents can be made to mount with unerring certainty some 10, 20, 50, or 100 feet, and then begin their gravitating course towards the outfall, or be pushed on by the same power along a level or rising main in any required direction.

Formerly such a plan would have required a regular pump and motor with attendance on the spot, the expense and inconvenience of which led the engineer to make such lifting-stations only on a large scale, and as quite exceptional aids to gravity.

He was thus tempted to be content with flatter gradients than it was desirable or safe to adopt, but as there is no reason why Shone ejectors cannot be placed out of sight under any street or square without interference with traffic, and actuated by power generated by steam or water at any convenient place several miles distant, if necessary, from the several ejectors, the engineer is now free to choose the most favourable localities towards which, as centres, he can give an artificial fall for the collecting sewers of each district where a natural fall is not available. Plans and estimates have been prepared for the sewerage of several towns on this system, which show very considerable economy as compared with the unscientific system of the past. So there is no objection on that score to detract from the weight of the sanitary argument for its universal adoption, and I have no doubt that an absolute revenue will be gained by the delivery of sewage proper to the land in a more marketable condition than it has yet been offered to the farmer.

Passing from the pneumatic ejector above referred to, I will introduce to your notice another valuable improvement combining the most perfect sewer gas-trap with automatic flushing for house-drain or public sewer, which we owe to the same inventor, who, recognising its analogy with his pneumatic ejector, has called it the hydraulic ejector.

Both the pneumatic and the hydraulic ejectors are intermittent in action, collecting and storing for a few seconds, or a longer period of time, whatever sewage is led into them, and ejecting their contents automatically, and with perfect certainty, the moment they become full.

The only limit of height to which the *pneumatic* ejector can project its contents is the air-pressure, which it is economical to apply; but the *hydraulic* ejector, as its name implies, is limited by the total fall or head of sewage, and of course it is not pretended that it will do more than discharge in one gush what would, if it had been clean water, have flowed down a pipe which had the same fall distributed evenly over its whole length.

With dirty water or sewage, however, the advantage of storing up and discharging in gushes by syphon action has long been recognised and applied by Mr. Rogers Field, C.E., in his well-known flush tanks. In circulars describing the original flush-tank of this inventor, its two defects were very candidly intimated by the recommendations (1) to throw a jug of water in suddenly to start the syphon action, if the tank at any time failed to discharge itself automatically; and (2) to remove the cover and clean out sediment from the tank occasionally.

Now, servants and others are not always very attentive to the directions of those interested in the regular working of any contrivance; and I think Mr. Shone has taken the very simplest and most practical means for dispensing with the necessity for issuing any directions for insuring the perfect working of his *hydraulic* ejector by pivoting over it a tumbling-box or basin, which, when filled by a small pipe—say from a sink or any other convenient source—will automatically topple over and right itself. It is thus evident that when the tank has been filled by the other discharges of the house or the sewers led into it, the next succeeding overturn of the basin must inevitably start the syphon action, which will empty the tank as effectually as Mr. Rogers Field's jug of water poured in by hand.

The second precaution suggested by Mr. Rogers Field has been obviated in an equally simple manner by starting the syphon from the very bottom of the tank which shelves down to that point; so that any sediment accumulating there is subjected to the full force of the discharge, and must go out in front of the lighter contents of the tank.

Mr. J. C. Edwards, of Ruabon, manufactures these ejectors in the simplest possible manner, by making a fire-clay bottom and cover to fit one of the ordinary 2′ sanitary pipes, set vertically to form the body of the tank, the syphon being composed of ordinary 4″ sanitary pipes, cemented together as usual. I should here mention that Mr. Rogers Field has introduced a very ingenious improvement upon his old form of tank, to which alone I have alluded above. This is called the annular syphon, and doubtless works well with clean water or *screened* sewage in tanks of large dimensions; but, owing to the cubic space occupied by this annular syphon, which must necessarily be deducted from the total internal measurement of the tank, as rendered non-effective for flushing purposes, it cannot, I think, be so economically applied on a small scale; and it is highly probable that the rags and miscellaneous articles always found in *unscreened* sewage would lodge on the sharp edges presented to the outflow of the sewage, even if the annular space were as favourable for that purpose as the simple pipe usually employed.

Alfred E. Jones.

On the Self-providing Sanitary Capabilities of Isolated Middle-Class Dwellings.

Dwellings possessing the qualifications of being healthy and comfortable, combining sound sanitary arrangements and construction with suitable and appropriate design, are what every one professes to set a high value upon. To attain these desirabilities it is essential that the house should be properly arranged, drained and ventilated, and provided with a sufficient supply of pure water; and the main object of this paper is to show briefly and concisely to what extent this is capable of being carried out in comparatively isolated cases, whereby the house is made self-sustaining or providing, relying on no exterior influences, but containing in itself an abundant and sufficient means for its own water supply and sewage disposal. In cases where premises are in an urban district and the house drains empty into the public sewer, whilst a constant and never failing supply of water is derived from the Company's mains, the questions respecting these two important items become comparatively easy of solution. The dwellings that I refer to are houses which do not possess these advantages—houses and premises in out-lying districts, houses of about 35*l.* to 40*l.* yearly rental, with perhaps a trifle more than half an acre of land attached, numbers of which are scattered about in villages and at short distances from the outskirts of towns. These are the places frequently to be met with where visitors sometimes resort to for change of air and the benefit of their health, under the impression that the atmosphere being normally pure the air of the country house is free from pollution. At the same time, could they only be aware of the general unsanitary condition of the house and its surroundings, they would fly the place. They never trouble themselves concerning the arrangements and state of the W.C., the domestic offices, the cisterns and tanks from which the water for dietetic and household purposes is continually being drawn, the condition of the well and the ground adjacent to the dwelling. On the assumption in the present instance that the arrangements of the house in question have been duly considered as regards convenience and design, we will proceed to discuss the important questions of ventilation, water supply, drainage and sewage disposal, which devolve directly upon the sanitary engineer.

1*st. Ventilation.*—Proper ventilation is one of the most important requirements for the maintenance of public health, being the agent for the thorough distribution and circulation of fresh air, that element which everybody prizes so highly and which is so essential to existence. According to Dr. Angus Smith, a fairly attainable standard of pure air may be taken to contain of nitrogen 79·00, of oxygen 20·96, and of carbonic acid ·04 per cent. Air with a loss of only ·21 of oxygen, and the substitution of a similar amount of carbonic acid becomes perceptibly deteriorated, so that the result when it is vitiated to the extent of 1 per cent. must necessarily be considerably worse. It is calculated that in 12 hours an individual body would vitiate 900 cubic feet of normally pure air to the extent of 1 per cent.; and it is therefore of the utmost importance that the whole of the rooms contained in the house from the cellar to the attic, more especially the bedrooms, where we remain for eight or ten hours at a time, should be properly ventilated and provided with suitable means for the vitiated air to escape. Assuming that the sleeping apartment is 10ft. × 10ft. and 9ft. high = 900 cubic feet (not an uncommon size), and occupied by a man and his wife, they would in only six hours vitiate 900 cubic feet of fresh air. If any one from the open air enter such a bedroom when the occupants have just vacated it after a confinement of *eight* hours, the almost sickening character of the atmosphere will at once make itself apparent. But what can be expected? The door has been shut, the window closed, the unused fireplace is probably stuffed up, and there is no ventilator. Carbonic acid gas, though naturally heavy, immediately it is generated in a heated state rises towards the ceiling, and it will invariably be found that the atmosphere of a room is several degrees warmer and infinitely more disagreeable at the ceiling level than at the floor level. A simple and efficient mode of ventilation is to admit the fresh air by means of a grating or air brick, built in the external wall at the level of the floor of the room, with an opening from this to the back of the skirting or dado, either terminating at its top or carried up by means of a vertical pipe of 4in. or 5in. diameter to a height of four or five feet above the floor and covered with a grating of wire gauze. These tubes, commonly known as Tobin tubes, can be fixed by the side of the window and concealed by the curtains. Provision should be made for the formation of an air shaft or flue in all chimney stacks, to serve the sole purpose of ventilation, commencing in the basement, carried up through the different floors, and terminating with the flues of the chimneys in one stack. Communicating with this flue and in the ceiling of the rooms ventilators should be inserted. The volume of warm polluted air at the top of the rooms being extracted by these ventilators, will carry with it all noxious gases and exhalations, and fresh air will simultaneously be drawn in through the lower aperture to supply the loss of the displaced vitiated atmosphere. The air of the apartment being preserved fit for respiration by these means, no nuisance is experienced from dirt and smoke, which is so often attendant on the introduction of valves into chimneys; and I have never found in the winter time (whether with a fire burning in the room or not) that the temperature has been unduly affected by the incoming cold fresh air. The closets should be against an external wall and entered through lobbies, both being thoroughly and permanently ventilated by the windows. The foregoing is a simple, inexpensive, and efficient method of ventilation without draughts, possessing no complicated contrivances; and it should always be borne in mind that any ventilation dependent upon artificial and mechanical means for its action cannot be reliable owing to the possibility of its getting out of order.

2nd. Water Supply.—The manifold uses of water are so universally known and appreciated that it is almost unnecessary to speak of the incalculable benefit it is to mankind. The question now under consideration is the best source from which to derive a sufficient supply. Mr. Bailey Denton, in his admirable work on Sanitary Engineering, says: 'I hold the opinion that in fact there exists no more certain source of a pure and sufficient supply than that of properly collected and properly filtered rain water which is, with care, to be secured by all persons alike. There is no cleaner surface from which to collect rain than that of roofs formed of slates and the harder description of tiles, if pains are taken to prevent the growth of vegetation, the collection of decaying leaves, and the deposit of the excrement of birds.' Most houses have a wing at the back usually containing a scullery, &c., with small bedroom over, and the roof of this portion is nearly always a little lower than that of the main building. On the walls of this part, which should be constructed of strength, should be fixed two galvanised iron cisterns capable of holding 500 gallons each, and immediately adjoining these, and connected with them by means of stop cocks, a smaller one should be placed so as to form a catch-pit into which the whole of the water collected from the roof should be led. In this catch-pit should be placed some coarse sand and fine gravel through which the water would have to pass previous to entering the two cisterns. This would clear it from any suspended impurities it might have collected from the roof or air in the shape of dirt, soot, decayed leaves, or excreta of birds. Suitable overflow pipes should be fixed to each of the cisterns, which could be easily and separately emptied for cleaning by means of the stop cocks and two draw-off taps, the whole being covered with the wing roof and properly ventilated. The advantages of this arrangement for storage at once make themselves apparent. By adopting this method the expense of conducting the water by means of pipes from the roof to an underground tank is avoided, as well as a pump and the attendant labour of pumping it up again. The utility also which it possesses, on account of the pressure derived from its elevation, renders it important in case of fire. The cost of a perfectly watertight underground tank to hold 1,000 gallons properly constructed with brickwork or concrete, and rendered in cement, with a suitable catch-pit and the necessary inlet and overflow drains, would be £11 10*s*, and the cost of the cisterns above mentioned would be about 30*s*. more, whilst the superior ventilation and access of the latter, in addition to the increased facilities for cleaning strongly recommend it, and the slight additional cost is more than counterbalanced through the saving effected by dispensing with the conductor pipes and pumps. Assuming the area of the house to be 1,000 square feet, and the mean annual rainfall to be 35 inches (and during the recent dull, wet, and cloudy seasons this amount is somewhat under rather than over the mark), the mean daily yield of water derived from the rainfall descending on such a surface (as calculated by Mr. H. Sowerby Wallis), after allowing 15 per cent. for evaporation, would be 42·4 gallons. The quantity of water used by persons in rural districts, as estimated by Mr. Bailey Denton, does not amount to four gallons per head per diem for drinking, cooking, personal ablutions, washing the cooking utensils and the clothes we wear; whilst the additional supply for household purposes, if the rules of cleanliness are duly observed, including that used in W.C's., washing floors, &c., does not bring the total amount up to eight gallons per head, and my own experience for the last four years (with rain-water supply) is that seven-and-a-half gallons per head per diem, where five persons occupy a dwelling, is an abundant supply for a house of a similar description to the one now under consideration. Soft water is, in every respect much superior to hard for cooking and household purposes, and when properly filtered is equally pure and wholesome, and in many instances more so, than that supplied from wells or by Water

Companies. From the foregoing calculations it will be seen that an ample supply of water would be provided by means of the rainfall for the use of five persons. The water used for dietetic purposes should be drawn from a self-supplying oxydising filter supplied from the cisterns. The advantage of this filter is that it is self-supplying, whereas if the water had to be carried in many cases, it would probably not be attended to and the water would not be filtered at all. The water for household purposes should be drawn direct from the cisterns by means of a tap, whilst that used for the W.C's should be supplied through water waste preventing cisterns.

3rd. Drainage, &c.—Having thus arranged for the ventilation and water supply, we must now proceed to consider the closet arrangements, together with the drains and sewage disposal of our house. Commencing with the closets, long experience proves that those for water are undoubtedly the best. Two of them should be fixed, each on different floors, one directly under the other. The description of apparatus that I should decidedly give the preference to would be the trapless ones, several good specimens of which are now in the market, though, by the way, is it not rather paradoxical for certain makers to advertise *trapless* closets having *trapped* overflows? The overflow from the pan should be carried through the wall to empty on a grating outside, instead of being trapped into the soil pipe, although, by using the water-waste preventing cisterns, overflows are almost unnecessary. The old pan closets, with their iron containers, are highly objectionable, and always to be avoided; and even closets having a hinged valve at the bottom of the earthenware pan are far from reliable. I have found from experience, that in one or two instances this valve closet is liable to frequent stoppage (though this might in a great measure be obviated by a larger passage-way through a lower trap); in fact, they barely let clean water away fast enough; and if the user should happen to let the handle go down by itself, the valve not only catches and throws up a portion of the water in the trap, but hits back the incoming flush in a manner that is anything but pleasant, whilst the slightest obstruction between the valve and the pan lets out the after flush. It is a well-known fact that the water seal of a trap is useless when there is any great pressure of sewer gas, which generally manages to force its way through; whereas the solid seal of the plug in the trapless apparatus effectually prevents the passage of any noxious effluvia, and the flush of water is considerably more powerful and direct when there is no tortuous passage through traps. The contents of the closet should pass through a suitable bend, having a good fall, direct into a 4″ galvanised iron soil pipe, which should be fixed outside the external wall, and continued up as a ventilator, with perfectly air-tight joints, and terminate above the eaves of the roof with an open conical covering. Excreta appears to have a natural affection for lead, and adheres to it with wonderful tenacity. I have seen 4″ soil pipes of lead which, when new, were as clean and smooth as the interior of a telescope, and fixed vertically, fairly choked and stopped up in two years, whereas some pipes of galvanised iron, under similar conditions, were not nearly so foul. The soil pipe should be connected direct with the drain by means of an easy bend, so as to form one continuous flue from the cesspool to the roof of the house. This flue serving the double purpose of ventilating the cesspool and draining the W.C.'s, no disconnection or break whatever should be formed, neither should there be any trap fixed at the foot of the soil pipe, this latter frequently causing greater evils than those it professes to cure. By this arrangement traps are entirely dispensed with, the trapless W.C., as previously stated, effectually preventing the entrance of any sewer gas. This drain should be formed of 4′ glazed stoneware pipes of best quality, perfectly shaped and glazed, put together with a luting of clay, and securely jointed into the sockets with cement; it should also be bedded in and covered over with concrete, and made absolutely watertight, being laid to a fall of one in fifty, in a straight line from the cesspool to the foot of the soil pipe, at which point access could be obtained from a lidded or inspection pipe, thus greatly facilitating cleaning the drain in case of a stoppage. Adjacent to the soil pipe, and in a suitable position, should be fixed one of Field's self-acting flush tanks, over the grating of which should empty the wastes from the sink and the overflows from the cisterns and W.C. pans, their ends being provided with light hinged brass flaps, thus entirely preventing the entrance of any noxious gases that might possibly arise. The tank, being provided with a proper ventilating pipe, should have its outlet connected into the sewer. The important advantages derived from the intermittent discharge of Mr. Field's admirable invention for flushing drains, and preventing them getting choked or silted up, are so well known and appreciated to need no comment at my hands. The cesspool being constructed to hold 2,000 gallons, and made absolutely watertight, should be placed as far as possible away from the house, and should also be a double one, having an iron grating or drainer fixed in the division wall, so that the solid matter would be retained in the first compartment. This could be taken out once a year, and after being mixed with ashes, utilised for manuring the kitchen garden, and would form a particularly excellent dressing for stiff clayey soils, whilst the contents of the second compartment, which would be of a comparatively liquid nature, could be drawn up through a liquid manure-pump, and used over the ground for the trees and vegetables, &c., as required. The cesspool should be fenced round, and both compartments ventilated by means of open gratings in the stone covers, at their respective tops, through double trays of charcoal, as well as an air pipe connecting the two, and the soil drain already referred to. Isolated as the dwelling is from any system of sewers, and taking all things into consideration respecting the house and its surrounding ground, the utilisation of the sewage, in conjunction with the contents of the ash-pit, is undoubtedly in all respects the most advantageous method of disposal. It may probably be noticed that in this paper there is no mention made of surface water. Rain falling otherwise than on the roof would be caught and retained by the ground, it being noticeable that country houses seldom having any paving or other impermeable surfaces around them, but generally grass or garden ground instead, require no provision for carrying off the surface water, which is absorbed by the natural soil. Referring once more to the subject of ventilation, the reception rooms and offices of well-planned houses can generally be efficiently ventilated by a judicious arrangement of the doors and windows. But the thought of an open door or window in the bedroom appears to cause such an universal shudder, that it would be beneficial to have this apartment ventilated by the means previously proposed, more especially if we take into consideration the length of time it is occupied. It is desirable, under some circumstances in the winter time, to have the incoming current of fresh air warmed previous to entering the apartment; this can be done with heated pipes, though the admirable stove, invented by Captain Galton, and which bears his name, effectually accomplishes this. Ventilation is, however, an elastic subject, and must of necessity be governed in a great measure by its surrounding conditions.

In concluding this paper, a word respecting the present rage for patent sanitary appliances may not be out of place. This seems ever increasing, and the competition is now remarkably keen between the numerous manufacturers, some of whom pirate and adopt each other's ideas and inventions in the most serene manner; and it is surprising to see the trivial, and in some instances almost silly, things for which patents are taken out. True, there are some really good and useful inventions in the market, but the majority consist of imitations and slightly altered adaptations, some utterly worthless. The public are induced to purchase through the puff and plausible, but apocryphal, statements contained in many of the circulars and advertisements of these contrivances for house sanitation, so-called sanitary appliances, frequently unsightly, and seldom attaining their professed ends. A good and useful invention is sure to have a host of imitators, who alter and modify (and sometimes do actually improve upon it), so that although the principle remains the same, the component parts differ so greatly that it is hardly recognisable, and the result is so and so's *improved registered.* It is impossible, however, in sanitation to lay down a hard and fast law that applies to all places alike, circumstances so alter cases, that what would be considered most suitable and proper arrangements for one dwelling might be ill-adapted for another. The different points must be carefully considered, and their advantages determined and utilised by the engineer, according to their suitability to meet the requirements for the maintenance of health.

GEORGE ARTHUR FOSTER.

Mr. S. JONES (Sheriff of Exeter) eulogised the distinguished services of Mr. Rawlinson, and proposed a vote of thanks to him for his presidency over the Section.

Mr. BODLEY seconded the motion, and it was carried by acclamation.

The PRESIDENT returned thanks. It had given him great pleasure to visit Exeter, in which he should take some interest, for his mother was a Devonshire woman, married from Exeter.

The Sewerage of Memphis (*Illustrated*).

This paper, which was read in the Engineering Section by Mr. Rogers Field, B.A., C.E., will be found at page 291, *et seq.*

The proceedings of the Section then closed.

Dr. Richardson then read his lecture on 'Woman as a Sanitary Reformer' (see pages 183 to 202), and was frequently applauded.

On the conclusion of the lecture, a vote of thanks was proposed by the Bishop of Exeter. He had listened to the lecture with great attention, and he trusted that it would receive the consideration it deserved. It struck him that women were particularly fitted to take part in what the lecturer had called upon them to perform, for they had eyes, in nine cases out of ten, where men had not; and noses in nine cases out of ten where men had not. Women, as they knew, were often led at once to a point at which a man only arrived after careful investigation. Was it not the plague of a man's life that woman not only claimed to be right, but very often was right? They did not know how it happened, but it was a most provoking fact. He took it that the lecturer did not mean that before they commenced anything in the direction indicated they should study all he laid down, but that they should make use of, and cultivate, the knowledge they possessed.

Professor De Chaumont seconded the motion, which was carried by acclamation.

A vote of thanks to the Mayor concluded the proceedings.

LECTURE TO THE CONGRESS.

LECTURE.

Woman as a Sanitary Reformer.

Two of the wisest of men, and by necessity, therefore, both of them Sanitarians, Solomon and Xenophon, have laid down rules bearing on the duties of women who rejoice in being called wives as well as women. 'A good wife,' says Solomon, 'worketh willingly with her hands.' 'She is like the merchants' ships, she bringeth food from afar.' She is an early riser, and sees that everyone has an early breakfast. 'She riseth while it is yet night, and giveth meat to her household and a portion to her maidens.' By exercise she strengthens her limbs. 'She layeth her hands to the spindle and her hands hold the distaff.' She knows that where there is poverty there can be neither health nor happiness. 'She stretcheth out her hands to the poor; yea, she reacheth forth her hand to the needy.' She provides against the cold. 'She is not afraid of the snow for her household; for all her household are clothed in scarlet.' In clothing herself she combines artistic taste with usefulness as every woman is bound to do. 'She maketh herself coverings of tapestry; her clothing is silk and purple.' 'She maketh also fine linen and selleth it.' 'Strength and honour are her clothing.' She combines common sense with gentleness. 'She openeth her mouth with wisdom; and in her tongue is the law of kindness.' She is watchful and busy. 'She looketh well to the ways of her household and eateth not the bread of idleness.'

And these, says this wise Sanitarian, are her rewards: 'She shall rejoice in time to come.' 'The heart of her husband doth safely trust in her.' And, light of perfected human happiness! 'Her children rise up and call her blessed.'

The second of the wise Sanitarians, Xenophon, tells his story of the good wife in somewhat different terms and manner, and indeed with difference also of detail. He, treating of the household and of the economics of it, invents a dialogue. He makes Socrates and Critobulus hold a discussion which comes to this general understanding: that the ordering of a household is the name of a Science, and that the Science becomes the order and the increase of the house. Afterwards, Critobulus asks of the Master why some so use and apply husbandry that they have by it plenty and all the good things that they need, including health and all blessings; while others so order themselves that every good thing avails them nothing at all. 'These two things,' says Critobulus, 'would I like to have explained by you, to the intent that I may do that which is good and eschew that which is harmful. Thereupon, Socrates, the Master, recounts to his pupil that he once held a communication with a man who indeed might be called a good and honest man. He had already seen and studied the works of good carpenters, good joiners, good painters, good sculptors, and had seen how they attained to excellence; and so he desired to find out how they who had repute for goodness and honour attained their excellency. He looked for such an one first amongst those who were handsome, but it would not do; for he found that many who had goodly bodies and fair visages had ungracious souls. Then he bethought him to look for a man who by general sentiment was reckoned upon as good, and at last he found Ischomachus who was generally, both of man and of woman, of citizen and of stranger, called 'the good.'

Socrates is made to discover Ischomachus sitting in the porch of a temple, and, discussing with him many subjects, asks him how it is he is called a good and honest man. At this Ischomachus laughs. 'Why,' he replies, 'I am called good when you and others speak of me I cannot say. I only know that when I am required to pay money for taxes, priests or subsidies, they call me Ischomachus; and indeed, Socrates, I do not always bide in my house, for my wife can order well enough whatever is wanted there.' 'And did you yourself bring your wife to this perfection,' asks Socrates, 'or did her father and mother teach her?' 'As she was but fifteen when I married her,' returns Ischomachus, 'she had seen very little, heard very little, and spoken very little of the world; and therefore,'—he continues some way further on—'I questioned and then instructed her.'

It is very doubtful whether, in these days of supreme wisdom the first principles of Ischomachus, as he taught them to his beloved, would be at all permitted. I dare not certainly set them forth on my own account, although they bear directly upon the subject of my lecture. I record them, consequently, as I find them, leaving their author, Master Xenophon, who though dead yet speaketh, to assume the responsibility of so flagrant a series of propositions as will follow.

'Methinks, then,' says Ischomachus, 'that for the welfare of every household there are things that must be done abroad, and things that must be done within the house and that require care and discipline.' We shall probably be all of one mind, even now, on that point. The difference of opinion that will rage rests on the succeeding points of argument. 'Methinks, also,' he continues, 'that the God hath caused nature to show plainly that a woman is born to take heed of all such things as should be done at home, and these are the reasons for the belief. He, the Maker, hath made man of body, heart, and stomach, strong and mighty to suffer and endure heat and cold, or privation, to journey, and to go to the wars. Wherefore, he hath, in a manner, charged and commanded him with those things that be done abroad and not of the house. He, also, remembering that he has ordained the woman to bring up young children, has made her far more tender in love towards her children than the man. And, whereas he has ordained that the woman should keep those things which the man getteth and bringeth home to her, and knowing also that to keep a thing safely it is not the worst point to be doubtful and fearful, he has dealt to her a great deal more fear than he did to man; while to man, who must defend himself and his own, he has dealt out more boldness. But because it behoveth that both man and woman should alike give and receive, he has bestowed on them alike remembrance and diligence, so that it is hard to discern which of them has most of those qualities. He has moreover granted them, indifferently, the power to refrain from doing that which is wrong, so that whatever either of them doe better than the other is best for both; and because the natures and dispositions of them both are not equally perfect in all these things, they have so much the more need the one of the other; for that that the one lacketh the other hath. Likewise the law shows, and the God commands, that it is best for each to do their part. It is more correct for a woman to keep house than to walk abroad; and it is more shame for a man to remain skulking at home than to apply his mind to such things as must be done abroad.'

Ischomachus next illustrates to his wife the lessons to be learned from bees in the hive; and, improving still the occasion, he offers certain rules which, with actual reverence, I venture to epitomise. He was, in fact, a grand Sanitarian, this Ischomachus, and I do not think there would have been much sickness now in the world had wives, in general, been after the training of Madam his wife. The million of men of physic might have become reduced to thousands. And the women of physic? Well, I may relieve my mind at once and say it plainly; they might have become housewives of all houses.

Some lessons of economy are first to hand. The wife is to beware that that which should be spent in a twelvemonth be not spent in a month. The wool that is to be brought in is to be carded and spun, that cloth be made of it; and the corn that is brought in must be most carefully examined, that none which is musty and dirty be eaten as food. Above all, the same instruction that Solomon insists on is enforced with special fervour. The wife is to be most particular, if any of the servants fall sick, that she endeavour herself to do the best she can, not only to cherish them, but also to help that they may have their health restored to them.

A little further on the philosopher touches on the importance of perfect order in the house as connected with the health and wealth of it. He tells how he once went on board a ship of Phœnicia, and wondered that in so small a space such a vast number of things could be stowed away with so much neatness that everything could be found in a moment, even during the confusion of a storm.

From these lessons he teaches his wife, and thereby all wives, matters that are more particularly of a sanitary kind. A house, he says, has an ordination. It is not ordained to be gorgeously painted with divers fair pictures, though these may be excellent, but it is built for this purpose and consideration, that it should be profitable and adaptable for those things that are in it, so that, as it were, it bids the owners to lay up everything that is in it in such place as is most meet for the things to be put. Therewith he disposeth of places for things in due form, and assigns the uses of the various parts of the establishment, in such manner that the woman who presides over the whole shall know the parts in a truly scientific way.

The inner chamber or room, because it stands strongest of all, is to be the strong room in which the jewels, plate, and every precious thing in the belongings of the house must be securely located. The driest places are to be places for wheat; the highest places for such works and things as require light. The parlours and dining places, well trimmed and dressed, are to be cool in summer and in winter warm. The situation of the house is to be towards the south, so that in winter the sun's light may fall favourably upon it, and in summer it may be in goodly shadow. The wearing apparel is to be divided into that intended for daily use and that required for special or grand occasions. Everything belonging to separate service, to the kitchen, the bakehouse, the bathroom, is to be assigned to its own place and use. All instruments which the servants use daily are to be shown to the servants in their right places, and are to be kept there when they are not wanted. Such things as should not be made use of except on holydays and rare occasions are to be left in special charge of an upper servant, who should be instructed beyond the rest of the servants to observe the same rules as the mistress herself would carry out. 'At last, good Socrates,' said Ischomachus, 'I did express to my wife that all these rules availed nothing unless she took diligent heed that everything might remain in perfect order. I taught her how in Commonwealths, and in Cities that were well ruled and ordered, it was not enough for the dwellers and citizens there to have good laws made for them unless they chose men to have the oversight of those laws. In like manner then the woman should be, as it were, the overseer of the laws of the house as the Senate and the Council of Athens oversee and make proof of the men of arms.'

Finally Ischomachus touches on the mode by which his wife should maintain her own health. He observed about her, as a very strange habit, that upon a time she had painted her face with a certain unguent that she might seem whiter than she was; and with another unguent that she might seem redder than she was; and that she had a pair of high shoes on her feet to make her seem taller than she was. Whereupon, 'tell me, good wife,' said he, 'whether you would judge me worthier or more beloved if I explained to you what we are precisely worth, keeping nothing secret from you, or if I deceived you by declaring I had more than I really had, showing you false money, chains of brass instead of gold, counterfeit precious stones, red instead of scarlet, and false purple instead of pure and good?' She replies: 'The gods forbid that you should be such an one.' He then recalled to her her own deceptions; and when she inquired how she should be fairer in reality and not appear so only, he gave her as counsel, that she should not sit still like a slave or a bondwoman, but go about the house like a mistress and see how the works of the house go forward; look after all the workers and sometimes work with her own hands, by which exercise she would have a better appetite for food, better health and better favoured colour of her face. While likewise the sight of the mistress, more cleanlily and far better apparelled, setting her hand to work and, as it were, striving at times with her servants who should do most, would be a great comfort to them by leading them to do their work with a good will instead of doing it against their will. For they that always stand still like queens in their majesty will be only judged of by those women who are triumphantly arrayed. 'And now, good Socrates,' continued Ischomachus, in conclusion, 'be you sure that my wife lives even as I have taught her and as I have told to you.'

Were a modern sanitary scholar, such an one as now speaks to you for example, to presume to lay the basis of sanitary reform, through the influence of woman, on such simple rules as those given above, he might suffer for a trouble, which might, in truth, be called a presumption. Happy, therefore, is it that he finds the basis ready laid by two such masters as Solomon and Xenophon. Their sufferings are over; hidden in the inaccessibility of historical distance. Their words alone remain faithful as ever, and as true for to-day and for to-morrow as on the days when they first went forth. They are the basis of modern sanitary law with women as its administrators. I would not dare to add a syllable to their majestic common sense.

Good wives of the type of the wife of Ischomachus, would, in one decade, make domestic sanitation the useful fashion and order of the nation they purified, beautified and beatified.

I quote this basis of wifely work and duty, because I feel more deeply, day by day, that until it is admitted, and something more built upon it, sanitary progress is a mere conceit, a word and a theory, instead of a thing and a practice. It is in those million centres we call the home that sanitary science must have its true birth. It is from those centres the river of health must rise. We men may hold our Congresses year after year, decade after decade; we may establish our schools; we may whip on our law-givers to action of certain kinds; we may be ever so earnest, ever so persistent, ever so clever; but we shall never move a step in a profitable direction until we carry the women with us heart and soul. Adam had no paradise in Paradise itself, until Eve became the help meet for him. How then, in a world which is anything but a paradise, shall we transform it into anything like one till the Eves lend us a hand, and, combining their invincible power with ours, give us the help that is essential to success? We must go entirely with Xenophon in the belief that the human being is not perfected, either in thought or action, until the two natures are blended in thought and action. The man invents, the woman applies the invention; the man conquers nature, the woman makes useful the victory; the man discovers, the woman turns the discovery to due and faithful account; the man goes forth to labour, the woman stays at home to watch the centre common to them, and tend the helpless there. Yet both have remembrance, both have diligence, both have the power to refrain from doing what is wrong, and whatever either of them does better than the other, is best for both. And, because the natures and dispositions of both are not equally perfect, they have so much the more need the one of the other, since what one lacketh the other hath. In the art of cultivating Sanitary Science, this mutual understanding is necessity itself.

We ought not to blame womankind because it seems that women are behindhand in the work. They are not, in point of fact, behindhand at all; they are rather the forerunners in the race. Long before the word Sanitation was heard of, or any other word that conveyed the idea of a science of health, the good, cleanly, thrifty housewife was a practical sanitary reformer. Nay, if we come to the question of organisation itself, we have in this country, in that admirable Institution, the Ladies' Sanitary Association, the first of the great sanitary societies, which by its publications, its practical aid to mothers, its outdoor recreative parties to the stived-up children of the metropolis, and by various other means has set an example which will one day be historical as a part of the great movement in the promotion of which we are engaged.

There is not therefore one single difficulty in the way of making the woman the active domestic health-reformer. The only thing that requires to be put forward is the method of bringing her universally into the work, and, if I may so express it, making the work a permanent custom or fashion, to neglect which would be considered a moral defect. There are in England and Wales alone six millions to be influenced. The first suggestion is that the beginning of the crusade shall be a beginning that shall not drive, but lead; that shall not dictate, but patiently suggest.

If what Pope said of man be true :—

> Men should be taught as though you taught them not,
> And things unknown be told as things forgot.

In respect to the sex still more susceptible and impressionable, especially when those truly feminine duties which are connected with domestic health and happiness form the subject of advancement, it may with equal truth be said :—

> Women should ne'er be taught a thing unknown,
> It should be credited as all their own.

Nor can any finer or nobler occupation be imagined than is implied under this head of domestic care and nourishment of health. There are women who think it the height of human ambition to be considered curers of human maladies; content at best to take their place with the rank and file of the army of medicine, and not perceiving that the only feature in their career is its singularity, a feature that would itself become lost if the wish of the few became the will of the many. I would not presume to interfere, on this point, even with the wish of the few. At the same time I would with all my strength suggest to women that, to be the practitioners of the *preventive art of medicine*; to hold in their hands the key to health; to stand at the thresholds of their homes and say to disease, 'Into this place you shall not come, it is not fitted to receive you, it is free only to health, a barrier to disease;' to conjoin in this work so effectually as to be able to say to every curative practitioner who invades their cities, 'You may come in if you please, and settle down if you please, but there will be nothing for you to do, except to write up, after a time, as a warning to all practitioners of the curative school : 'Who enters here leaves hope behind;' to exercise practical power in such a manner, would, I venture to indicate, be as much above the exercise of curative art, as the art of making unsinkable ships would be above the toil of working at the pumps of a sinking vessel that was only sinking because it had been allowed to fall into a perfectly hopeless state and condition for resisting the strain of the deceitful sea.

I press this office for the prevention of disease on womankind, not simply because they can carry it out; not simply because it pertains to what Xenophon describes as their special attributes, their watchfulness and their love; but because it is an office which man never can carry out; and because the whole work of prevention waits and waits until the woman takes it up and makes it hers. The man is abroad, the disease threatens the home, and the woman is at the threatened spot. Who is to stop it at the door, the man or the woman? What does a man know about a house, about the very house he lives in, if he be a man employed at all? I asked as good a man of business as ever went on Change, how many rooms he had in his house? His reply was: 'What an absurd question.' 'Why absurd; the house is your own?' 'Yes, but I have never thought about it. You should ask my wife if you want to know. She will tell you all about it from the butler's pantry to the cockloft; but as I only go into two or three rooms myself, how should I be likely to remember? It is not my department.' That is so generally. The woman knows all about it, or if she does not she ought; it is in her department to know the whole matter by heart. The house is her citadel.

There probably is not a person who is given to reflect who will not in the main agree with me in these conclusions. The strongest-minded woman, the woman who would assert to her heart's content the right of womanhood to assume manhood, would, I think, agree with me in the main. She might and possibly would affirm that I do not go far enough; she might feel the position I have assigned to woman as too feminine in its tenderness and as a retrogression from the design of attaining the equality of power which she would consider necessary for the perfect liberty of woman from the bondage imposed by men. At the same time she would agreed so far as to admit that if her fellow-sisters everywhere could claim and hold and maintain such a power of practical knowledge and skill as I have pointed out, their mission in this world would be more greatly advanced and more nobly utilised than it is at this time. Nay, perchance, when she has heard me to the end and has well considered the tremendous power which the completed scheme would give to her sex, she might feel that her ambition would be more than satisfied by its accomplishment.

While women in general will, I feel sure, almost think it impossible that so much useful influence could be attainable, the majority will ask: 'By what process of training can we so govern domestic life that diseases may be prevented wholesale; that life in all its innocence and fascination may never, except by the most vulgar accident, be invaded by death; that adolescence in all its beauty and unfolding strength may be equally guarded; that manhood and womanhood may have the same protection; that middle age may be extended in intellectual and physical perfection into the grand decline; and that the grand decline itself may be so gentle, so peaceful, so beautiful,—yes, so beautiful, for there is a beauty in healthful old age that is unsurpassed,—that life shall be but a dream and death but a natural sleep? They will ask, I repeat, the majority of them, by what process of training can we help towards a triumph of science so beneficent?

I devote myself from this point of my discourse to give some answer to that question. I state at once that the training required is simple, beyond simple; that every woman who wills to go through it may go through it and may become mistress by it of the destinies of the world. Not the Fates themselves were more the mistresses of the destinies of the race than the women of an educated Commonwealth who were conversant with the art of the prevention of disease and premature decay.

Ischomachus, content to have his wife taught housewifery pure and simple, would, I think, in this day be not quite so content. He would wish that she should know everything about the house in which she and he and their family dwelt; he would wish also that she should know something of that house of life which belongs to herself and to all hers. He would not desire that she should become a profound anatomist; he would not care for her to enter on the subject of experimental and practical physiology; he would scarcely aspire that she should try to emulate Hippocrates in diagnosis, or Dioscorides in therapeutics. But with our modern knowledge in his possession he would, I venture to suggest, have begged of her to learn a few principles which would help her to understand the reasons for the necessity of her domestic cleanliness and wifely care. As he is gone before these desires could be current, I will, with much respect, take his place, and indicate what every woman who aspires to be a wife, a mother, and a practical Sanitarian ought to learn in this particular direction.

She should master physiology so far as to understand the general construction of the human body. She should know the nine great systems of the body: the digestive, the circulatory, the respiratory, the nervous, the sensory, the absorbent and glandular, the muscular, the osseous or bony, and the membranous. She should be led to comprehend the leading facts bearing on the anatomy and function of these systems. She should understand what part food plays in the economy; the nature of the digestive ferments; the primary and secondary digestions; the method by which the digested aliment finds its way into the blood; and the specific purpose which is answered by and through the application of foods, proximate and elemental. She should be rendered fully conversant with the different changes of food that are required for the digestive process in different periods of life; the extent to which the digestive powers should be taxed in infancy, childhood, adolescence, maturity, first and second decline, and old age. She should be made aware what substances, taken as food, are of real and what of spurious quality. She should be taught the relationship which solid foods hold to liquid foods or drinks. She should be told what drinks are foods, and she should specially understand what are the particular foods required for the young during the periods of active growth. In illustration of the value of this last-named fact, it may be stated that if women only knew what foods were requisite to feed the skeleton or bony framework of the living body while that skeleton is in the course of growth, and if she would act upon her knowledge, as she almost certainly would if she possessed it, there would hardly be one deformed child left in the land in one or two generations. Rickets, with all its attendant miseries of bowed legs, crooked spines, and humped backs, would pass away as if by the spell of an invisible enchantress.

After the understanding of the digestive system, the woman should learn the principal facts relating to the circulation of the blood, the organs of the circulation, the heart, the arteries, the capillaries, the veins, and the blood itself. She should know completely the mechanical construction of the heart, its coverings, its cavities, its lining, its valves and the uses of the parts. She should understand the work of the heart; how it rests when the body reclines; how easily its daily tonnage of work can be increased by perfectly unnecessary strains and stimulation until a day and a quarter of hard work may be compressed into one day, and a fourth of the vital spring of the heart for that day be lost for ever as so much taken from the sum total of life. She should know how the heart is sympathetically moved in its action, and may be weak or strong, regular or irregular, calm or excitable, by the influence of external impressions which, in passing, may seem nothing and yet be everything. She should learn that in early days the whole after-life may be shaped, I may say, by the tone that is given to the heart, and that whether in its pilgrimage a Faintheart or a Greatheart shall occupy the stage on which a young life is to enter shall turn absolutely on this one educational fact, the skill of the trainer of that simple and susceptible mechanism, the human heart, while yet it is susceptible, fashionable, and undetermined.

Nor should she, in respect to the healthy organism, be less informed respecting that breath of life which is ever being breathed into the living thing by the Eternal Chemist whose constructions and resolutions are the motions visible and invisible of his eternal universe. The complete structure of those breathing lungs should be as plain before her as the outward form of the things she knows best. The course of the blood, like a curve from one side of the heart to its other side through the maze of spongy lung-tissue, should be easily traced. The expansion of the six hundred millions of little vesicles of the lungs, which the air inflates, that it may, over so vast a surface, expose itself to the circulatory blood in its rapid passage through the vesicles; the change that takes place in the blood during the passage; the gas that is robbed from the air by the lungs; the gas that is given up to the air by the lungs; the change in the colour and character of the blood that attends these processes; the course of the changed blood bearing its vital air, or oxygen, in myriads of tiny cells through the arteries to the body at large; the spreading out of this blood over the vast sheet of minute vessels which make up the vital expanse, the vital furnace, the vital foundry of the body; the consumption of vital air there; the unloading of new material or pabulum there; the removal of old and effete structure there; and the recharge of the blood with the gaseous products of animal combustion there;—these things ought to be as familiar to the mind of our scholar as the commonest things in life; the letting in of air to feed the fire, the entrance of the servant with coals, the burning of the fire in the grate, the use of the fire for various domestic purposes, the opening of the ventilator to allow the smoke to ascend the chimney, and the removal of the ashes and débris that more new fuel may be supplied to keep the fire alive.

Equally clear to her should be the leading facts bearing on that receptive system of the body into which the external universe transports itself, and from which, in reflex response, the acts of life, the expressions, the movements, the thoughts, return in wavelike repetition back again, to become themselves external phenomena, linked, as such, with all the visible universe. Those nervous centres, locked up in the skull and spinal cord, to receive and retain and remit; those doubly-acting nervous cords, bearing the impressions to the centres and bringing them back again; those exquisite nerves, so finely set and balanced and distributed for play of reason and volition; and those other sympathetic, nervous centres in the trunk of the body, allied to the viscera, which they serve, and governing the automatic motions on which the volition has but indirect control—centres of emotional and what is commonly understood as instinctive faculties,—these parts, these systems, all, in respect to general function and vital value, should be as familiar as the course of the sun, from whom, in essence, they spring. And with these nervous organisms the fields of the senses, too, should be made clear; the outline of the plan of an organ of sense being as simply comprehended as the plan of a camera or other well-known human instrument.

Let me interpose one practical illustration here of the value of knowledge bearing on the organs of the senses. Recall how many young people and middle-aged people are going about in spectacles, unable to see any object with the naked eye that is not uncomfortably near! Recall how many of these have also their backs distorted! Why this strange combination of deformity? Mr. Liebreich tells us. 'The greater part of it is induced while acquiring the art of writing. When the body is still being formed and is unconsolidated, the child is permitted to sit with the chest and back bent forward, and with the eyes close to the paper. Thus the natural refraction of the lenses of the eyeball is permanently perverted; the parallel rays of light are brought to a focus before they reach the retina, and there is produced the deformity of *short sight*, for the correction of which an artificial lens or glass is required. At the same time the back abnormally bent retains its abnormality, and short sight and curved spine go together, twin defects of one error which ignorance of the simplest principles permits the devoted and affectionate parent to overlook, as if it were a necessary and therefore irrepressible and irremediable evil. Let us suppose the women of our country trained to a knowledge of the first and elementary truths about visual function, and guided by them, is it not all but certain that another deformity would in a generation become virtually a physical misdemeanour of the past?

To this knowledge of nervous function it would be advisable to add to the store of elementary principles a few facts respecting the great glandular system of the body; that system which produces the digestive and other active secretions, the saliva, the bile, the pancreatic juice; which absorbs the food; which takes up and, as it were, drains the tissues and eliminates those fluids and excretions by which the effete and useless animal material is removed from the body.

Of those little fleshy engines which clothe the skeleton, which are the active organs in animal motion, and which, impelled and directed by the nervous system are the active workers, the night and day labourers of the body, the muscles, the woman should learn sufficient to be made aware of the advantages of so training the muscles to work that they shall be daily exercised, shall not be subjected to overstrain, shall be equally subjected as far as possible to healthful labour, and, by good and simple and systematic culture, form that external build of man and woman which the classic ancients of the classic age would accept as the model of the most powerful, the most symmetrical, the most beautiful of the types of the genus *homo*.

And of the bony skeleton, on which the muscular engines are laid, and which act as the passive framework and levers of the engine, she should gather enough information to be conversant with all its outlines of form and chemical construction. She should ascertain from her teacher that the bone, made up of two parts, an organic gelatinous part for shape and basis of support, and an earthy part for strength and durability, cannot be supplied with material for construction in unequal portions without yielding a deformed skeleton. That, deprived of its organic gelatinous part, it will become brittle and easily broken; that, deprived of its earthy part, it will be distorted, bent under the weight of the body, and yield bended limb, crooked spine, and diminutive form as the result of this one and serious deprivation of constructive material. The educated woman who had seen the exquisite build and symmetry of the skeleton; who had taken measurement of the cavities in which such vital organs as the lungs and heart are placed; who had fixed in her mind's eye the graceful curve of the spinal column; who had gathered the main facts about the sustaining parts of the skeleton; would, moreover, collect from the physical demonstration a series of inferences which would make her turn pale with dread and disgust whenever she detected one of her foolish sisters strangling her body in tight corset and murderous belt, to make it hideous as well as useless, or who was intent on destroying the perfect arch of the foot in a contracted foot-vice elevated on a pegtop.

Lastly, the woman should attain so much instruction in reference to the great membranous expanses as to know them also. She should study with special care that extended membranous expanse—so sensitive to external influences of heat and cold, so grand a breathing surface, giving up from its myriads of little sweat-glands volumes of invisible water, vapour, and gases, which, left in the body, must either be expelled by the lungs or remain to dull the sensorium and weaken the physical activity,—the skin. She should learn from this the necessity of keeping the functions of the skin in due cleanliness and condition for work, so that the bath, seen to be more than a luxury, should be considered as one of the necessities of the daily life, like a daily meal of cleanly substance.

The living house thus generally learned, the Sanitarian helpmate for us who can do so little beyond our suggestion, would be tempted to study until she completely mastered it, the mysterious construction of that deadly-lively house, which until lately the architect and builder have pitchforked into street and square with facile and contented wisdom of wigwam descent. She would require here, like Madam Ischomachus, to grasp all the details with as much precision as the old Phœnician merchant, or the modern yachtsman who knows the details of his immaculate craft so well, that even in storm, hurricane, fire or disease, all resources are ready at hand. She would require in these days to know this and something more. She would want to learn how the immaculate house is in every room provided with at least moderate ventilation. She would require to find out how most effectively and economically she can maintain in the varying seasons an even and equable temperature. She would aim to consider in what way she could keep the air of the house free of that most objectionable of mischiefs, dust. She would demand to have marked for her on a map or plan the precise position of every drainpipe in the establishment, and would insist, with intelligent skill, on having every drain kept as systematically clean as the china in the housemaid's cupboard or the metal covers that make so many bright and effective pictures over the dresser of the well-arranged kitchen. She would see, not trusting to the mere word of anyone, that those drains were properly ventilated so that sewer air could never enter the domain except as a burglar might enter by special skill and violence, against which there is no absolute protection. She would learn enough of the chemistry of water, to enable her to determine with as much facility, as she could tell whether a looking-glass is clear enough to reflect back without fault the image of her face, whether a water was wholesome and drinkable; and she would have a sufficient amount of skill to direct how an impure water might be purified and made safe for her and hers to drink and use for all domestic requirements. She would see to it that sunlight found its way as freely as possible into every apartment. She would see that damp had no place in any apartment. She would insist that where any living thing that ought not be present in a house exists in it, that house is unclean, and in some way uninhabitable for health; since health will not abide with anything that is uncleanly. She would see to the biennial purification of the dwelling, as though a Passover were still an universal belief and practice. She would make the very act of cleaning and cleansing clean; she would make the very places for cleaning and cleansing —the scullery, the landing, the bath-room, the laundry—the cynosures of the household.

In the art of perfection or towards perfection of health the educated woman would in her domestic sphere, bring her best energies to understand the selection, the purification, the preparation, and the administration of foods and drinks. I have shown by two striking examples how, by a simple application of knowledge, she might prevent two great national disfigurements and disgraces of ignorance. She may go far beyond that advancement, great as it is. As she would keep seeds of certain pestilence from her fold, or vulgar poisons that kill outright, and proclaim at once with loud voice, 'accident, disease, or murder,' so would she do her best to keep out those refined and subtle poisons which, in and under the name of strong drinks, bring silently more accident, disease, and murder into this inscrutable world than all the other poisons put together, unlicensed though they be and so little liked by the exciseman that he would fly them any distance, the De'il himself in company, rather than so much as touch them with his divining rule.

I think too that in regard to foods, an intelligent study based on a knowledge of the natures and uses of foods would enable her not merely to carry out the best selections and preparations now known, but would lead her to introduce certain new and much improved methods of feeding. That she would acquire a thorough knowledge of the best art of cookery I take for granted; that she would acquire a good knowledge in choosing foods in season I take for granted; that she would become an adept in detecting actual wholesome from actual unwholesome foods I take for granted; that she would find out what foods are most suitable for persons of different age and constitution I take for granted; and that she would distribute food with well-balanced hand, neither feeding over-indulgently nor parsimoniously, that also I take for granted. But I expect she would learn to do more than all these things in relation to food, and would help, perhaps lead, in a work of the future that is in the truest sense universal in its objects. She would be able better than anyone to put to the test the experience whether it is good or necessary to go to the living animal creation at all for human food. I do not wish to introduce any false sentiment into this question. It is unnecessary for me to say that every cultivated mind revolts at the sight of the shambles and an inner consciousness shudders when the veil is lifted which conceals the processes through which the animalised meal passes before it reaches the table. More to the point is it for me to wish to know whether it is philosophical, that is to say, truly physiological, for us to go to the inert and dead to get the best sustainment for the quick and the living. I am in doubt. It does not seem to me that man is constructed to be a carnivorous animal. It does not seem clear putting the anatomical argument altogether aside, that it can be good to go to secondary sources of supply for our food when nature bountifully presents them to us from her prime source. It does not seem reasonable that we should employ millions of living laboratories for our daily food, and take the risks of disease which they in endless forms produce and propagate for us, when we can get all that is necessary without the chance of such production and of such propagation. It does not seem certain, when we know that the vegetable world is the original source of every particle of living food, and that carnivorous animals have to depend on the herbivorous for their supplies, —so that carnivorous feeding is an anomaly rather than a basic principle of nature,—it does not, I repeat, knowing these things, seem certain that the cost of the support of the living laboratories is justifiable on any ground except the extravagant process of making work that work may be at hand and employment procurable. In old and barbarous times, when implements were few and animals were plentiful, it is easy to see why men should feed by hunting and by slaying; and it is easy to understand why in a becalmed sea a vigilant captain should set his restless crew to the employment of polishing an anchor. It is not so easy to see why in this day, when the great question of peace is food, cheap food, good food, healthy food, and when means for endless, refined, and ennobling employments are open, we should still maintain the practices of a barbaric era. Still I confess I am in doubt. I am not sure whether the necessity for the secondary supplies of food for man, from the animal world, are or are not necessary, and that doubt it is in the *rôle* of the educated woman to solve. Her discernment, properly and eagerly directed, would soon settle whether those about her were injured or benefited by an exclusive vegetable and fruit diet. The very timorousness which Xenophon describes would make her study the more watchful and her experience the more definite.

However she might solve this grand enigma, sure I am that in watching carefully over food and feeding, the educated woman would quickly discover a world of facts that would be of unspeakable value. It has been one of the endeavours of my life to show that we living men and women make in our own corporeal structures a refined atmosphere, which I have called a nervous atmosphere, or ether: an atmosphere which, present in due tension, distinguishes life: which absorbed or condensed distinguishes death: an atmosphere through which the external world vibrates and pierces us to the soul: an atmosphere which pure and clear brings us peace and power, and judgment and joy: an atmosphere which impure and clouded brings us unrest and weakness, and instability and misery. A physical atmosphere lying intermediate to the physical and metaphysical life: an atmosphere which our great colleague, William Crookes, might call radiant.

That atmosphere, serene or troublous, light or gross, bright or gloomy, we make in ourselves, not from ourselves, but from what we take into ourselves and transmute there. We make it from foods and drinks, and as we make it it makes us. Go into the wards of a lunatic asylum and notice amongst the most troubled there the odour of the gases and the vapours they emit by the skin and breath. That odour is from their internal atmosphere, their nervous ethereal emanation. They are mad : mad we say up to suicide or murder or any criminal folly. Can it be otherwise? They have secreted the madness; they are filled with it; it exhales from them. Catch it, condense it, imbibe it, and in like manner it would madden anyone! In one experiment of mine I have shown that a common product, a food if we like to call it so, a thing that can be made from food stuff, an alcohol, will by its mere artificial temporary diffusion through the healthy body bring on, for the time it is acting as a false atmosphere, such awful despair that the experimentalist can barely avoid destroying his own life.

See, from the study of foods, out of which the radiant or deadly atmosphere is made, what fields of discovery open to the mind. A mother, watching the effect of food on her gloomy saturnine child, may detect how she can so feed it that the cloud shall pass away. Happy mother of a child! Far, far happier mother, perchance, of science and hope. In some great establishments for the insane so much gloom is secreted in the nervous recesses of human frames that many times a day, but for excessive vigilance, some terrible hand would raise itself against itself, to kill itself. What if in a wiser day, however far off, the removal of that little cloud from a troubled child should show the way to the removal of those denser, blacker clouds which lower and create storms in human breasts, overpowering altogether the radiant nervous ether! What if from that minor event this greater one should follow! What nobler accomplishment of noble deed could woman perform, save and except when she is the mother of her kind?

Referring back to our friend Ischomachus, and Madam his lady, I said he would probably not wish that she, like Hippocrates, should be learned in diagnosis. Neither in this day should I press that as a part of the education of the sanitary female scholar. I do not say this as if to frighten anyone away from an art too obscure to be thought of, for diagnosis is one of the easiest and most commonplace of human acquirements when the superstitious mystery that is made to surround it is cleared away. But I say it for the reason that the art is not necessary for women except in a limited degree. I would claim, however, that to this extent it should be cultivated by women. They should know the correct names and characters of the more common diseases, and they should know, by sight, the everyday contagious or communicable diseases. To this knowledge of the communicable affections they should add a few facts bearing upon the periods of incubation of these diseases, the periods, that is to say, between the time when they are what is vulgarly called "caught," and the time when they are developed and in turn communicable, or again,to use a common term, "catchable." Thus to know that scarlet fever may be incubated in a few hours, while small-pox takes twelve days, measles twelve to fourteen days, and so on, is very useful knowledge. It enables the question of isolation of the unaffected or the removal of the sick to be rationally considered; it suggests inquiry as to the origin of the infection or contagion; and it gives reliance to those who are attending to the wants of the affected. In like manner it is well for women to know the critical periods, special dangers, and ordinary modes of termination of diseases. Beyond this, diagnostic skill, on their part, needs little further development.

At the same time all the best known methods of preventing disease should be at their fingers' ends, and the rule of the sick room should be their faithful care. The woman should know everything about registering the temperature of the sick room and degree of humidity; the mode of ventilation; the different special methods of feeding, washing, and changing the sick; the most efficient means of disinfecting, and of removing or destroying the poisons of the communicable diseases. How, in this way, the woman could help the physician none but the physician can understand. I have said many times, and, on the principle that:—

> 'Truth can never be confirmed enough,
> Though doubt should ever sleep,'

I declare it again, that if, in the management and treatment of any of the acute and of many of the chronic diseases, you gave me, in this climate, absolute control of the fire and the window of the sick room, I could determine the course of the illness. As many as you like of my learned brethren might come and go, and consult and prescribe; let me have exclusive right to those two influences, the fire and the window, and the fate of the sick man is in my hands, the best other efforts all but void and vain. How vital, therefore, the influence of the woman, educated to sanitary work, in the sick room. What an aid to the physician! Nor to the sick alone should this systematic care of the woman be directed. It should extend, more carefully than it has ever yet done, to the very young; to those who are in the first weeks and months of life; so that they be saved pains and impressions, which received and registered, if not remembered, may be penalties of after days. I conceive, in fact, there is no department of practice more neglected, in respect to principles, than the management of offspring in its earliest youth. Love there is plenty of; admiration unbounded; rational systematic training, the poorest that can be described.

I fear I am keeping you too long; let me then be content to point out but one more lesson for the modern edition of Madam, the wife of Ischomachus. She should have, in addition to instruction on all the points above-named, a good training also on some subjects which refer to mental as well as physical education, and to some qualities that lie somewhat out of the way of what is purely physical, and which yet obscurely lean towards it. In these directions she should understand the little appreciated law of temperaments; the nervous, the bilious, the sanguine, and the lymphatic. She should study the combinations of these, and she should observe how temperament influences health, taste, activity and disease. From this she would learn how different natures would intermix in work or play, and what work, what play, would suit the nature. The sanguine child, ruddy and red, with blue eyes, red hair, strong muscle, quick movement, restless limb she may set to study at books while she curbs exercise, with no fear that books will kill, for it will outlive any book. The bilious child with dark eyes, dark skin, black hair, stolid expression, thoughtful brow she will not set to the study of books as the work of life; for books may kill; physical exercise may save, but will never be carried voluntarily to injury. The nervous child with fair skin, light hair, blue eye, quick but feeble movement, timid glance, yet perhaps unbounded ambition, she will spirit gently; will balance between physical and mental labour; will apportion excess of neither, and will never urge unduly to any effort. The lymphatic child, large of body, pale, with grey or blue eyes, brown hair, shambling step, watery lip and slow determination she will rouse to action both physical and mental, with the full assurance that neither effort will do anything but good.

Beyond the study of the temperaments and the special dangers connected with them she should devote her mind to the consideration of what the learned D'Espiné has designated the mental contagions. She should study emotional contagion with special care, and on one emotion, that of fear, she should keep the most watchful observation, because she will discover it to be the most common and disastrous of all contagions. She will never excite it for a moment by story of superstition or dread. She will never suggest it. To tell a fainting or feeble person, 'You look weak, you look pale,' is, as she will learn, to add weakness to weakness, pallor to pallor, and ashes to ashes. She will lift up; disperse moral contagions wherever they are found; isolate the susceptible to them, as far as it is possible, from the centres of them; and through the windows of the mind let nothing pass but the sunshine of mirth and strength and beauty.

Finally, in physical psychological training there would stand out for contemplation, and action founded upon it, one more subject, that marvel of the marvellous in living phenomena, heredity of type and action, extending to health, and extending, alas! to disease in its deepest foundations. A little aid from books of learned men, of *the* learned man of this branch of knowledge especially,—you know I can only mean Darwin,—would help the scholar much; but the aid she will soon be led to find in the yet higher authority of nature will help her most. She will see the descents from good to good, and even, though fortunately with decreasing ratio, from evil to evil. She will see the conquest of death as a natural conquest over evil, and being now in the groove of nature, she will detect how even she may availingly help nature. One effort here as a Sanitarian would call forth all her powers. She will stand to resist with her full persuasive might that process which I have elsewhere called the intermarriage of disease. She will tell her sisters what that terrible process means. She will tell that diseased heredity, united in marriage, means the continuance of the heredity as certainly as that two and two make four; that madness, consumption, cancer, scrofula, yes, and certain of the contagious diseases too, may be perpetuated from the altar; and that the first responsibilities of parents towards the offspring they expect ought to be, not how to provide for wealth and position over which they have no control, but that preliminary healthy parentage, which is the foundation of health, and without which position and wealth are shadowy legacies indeed. Delicate ground, you may say. I admit the fact. But in a world in which those who study the living and the dead most carefully rarely see a man or woman hereditarily free from disease, even this ground must be entered on by the enlightened scholar. I touch on it here for the best of all reasons, that the subject it includes, affecting deeply the human heart in its sympathies and affections, is one on which the influence of woman the arbitress of the natures that are to be, is all potent for good or for evil.

To know the first principles of animal physics and life; to learn the house and its perfect management; to learn the simpler problems relating to the fatal diseases; to ordain the training of the young; to grasp the elements of the three psycho-physical problems—the human temperaments, the moral contagions with their preventions, and the heredities of disease with their prevention, these, in all respect and earnestness, I set before this Congress as the heads of the educational programme for our modern woman in her sphere of life and duty. Let these studies be hers, and once more may be applied to her the promise of that wisest of men, with whose words I opened this discourse: 'She shall rejoice in time to come. The heart of her husband doth safely trust in her.' And—sun and sum of all hopes, ambitions, happiness!—'Her children shall rise up and call her blessed.'

BENJAMIN WARD RICHARDSON, M.D., F.R.S.

SECTION III.

METEOROLOGY AND GEOLOGY.

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METEOROLOGY AND GEOLOGY.

The President of the Section, SIR ANTONIO BRADY, F.G.S., F.M.S., &c., delivered the following address :—

It is my privilege to address to you a few words, at this the fourth congress of the Sanitary Institute of Great Britain, an institution which, under our enlightened President and the other veterans in sanitary science with whom he is associated, is, I hope and believe, destined to do great things for the improvement of the health and happiness of the people.

The great aim of the Institute is to educate the people to a fuller sense of the necessity of better sanitary arrangements, and, secondly, to train a class of inspectors and artisans capable of superintending and carrying out sanitary works, designed upon the most improved principles of hygiene.

I feel much flattered by the trust reposed in me, of presiding over the deliberations of the section treating of meteorology, geology, and geography, in relation to health, and I could have wished that it had fallen into abler hands; but I must crave your indulgence while I endeavour to place before you some of the general leading facts and experiences upon which we base the generalisations which are the foundations of our science.

I shall venture to alter the order of the three parts of the subject upon which I have been invited to address you, and as geology, or the science treating of the history of the earth, is the basis on which the others rest, I shall place this before meteorology and geography.

These sciences require a due appreciation of the physical conditions of the world in which we live, and the laws which govern the changes to which it is subject, amongst which are climatology, and the arrangement and constant re-arrangement of the materials of which the earth is formed, and the forces and agencies by which these physical changes are affected.

My greatest difficulty in treating of this most interesting subject is its vastness, comprehending, as it does, the whole circle of the sciences, especially astronomy, the noblest of them all.

A few words, therefore, on the general cosmogony of our world may perhaps better enable us to grasp, and, in a measure, comprehend the vast changes continually going on around us, and to perceive how much depends on life and the hand of man in modifying the crust of our globe, and making it a more or less healthful residence for the people who inhabit it.

If modern science teaches us one thing more than other, it is that this world of ours was not created in its present form and condition, but that it has arrived at its present state by slow degrees, and by the agency of forces still in operation, though some of them, perhaps, not with the same intensity as in the earlier periods of the world's history.

By the aid of that most wonderful modern instrument, the spectroscope, we are led to the conclusion that our earth was originally a mass of nebulous, dim, hazy matter, thrown off from the sun, which contained all the elements of which our globe is composed; this matter becoming condensed by the cold of space, first formed a crust, not originally stratified like the rings of an onion, as some have supposed.

This crust, in progress of time, has been crumpled up, and mountains raised by the condensation and consequent contraction of its parts. It has all been greatly modified by the action of the elements, chemical agencies, and various other causes. The materials have been re-arranged and stratified, again and again, by denudation—action of currents in the ocean and rivers on land—so that new combinations of land and water have been continually formed. Both sea and land are constantly encroaching one upon the other, and are in a state of unstable equilibrium and constant change. It has been calculated that but for the forces bringing up fresh lands from the bottom of the ocean, as the abrading influences continually at work destroyed the existing lands, time enough has elapsed, and force enough has been exerted, to have reduced the whole earth to a dead level, which would in that case have been wholly submerged, and there would have been no dry land.

Heat is the principal agency by which these great upheavals have been effected. The volcano and the earthquake are the existing examples of this operation of force, and viewed in this light, instead of being destructive agencies, they really prove great conservative influences, modifying the other disturbing causes, and preserving the earth in a state fit for animals and plants to inhabit.

To the due proportion of land and water we owe the benign influences of meteorology and the various climates and soils suitable for the production of food for man and beast; but many other subsidiary causes have in all time tended to modify the crust of the earth, animal life being one of the chief. Some of the least of created beings, acting over æons of ages, have been destined in the economy of the universe to alter the nature of the surface of the earth, and even to form continents and islands out of the materials extracted by them from the ocean. Thus the minute confounds the wise, and magnifies the power of the Almighty, who, by such apparently insignificant means, has effected such magnificent results.

Out of many forms of animal life which have contributed to this, I will only allude to two, viz., the Globigerina of the chalk and the coral insect of our eastern tropical seas. By the former our chalk hills were formed. The Globigerina lived and moved and had its being in the primitive ocean. Its shell is so minute that 400,000 would not occupy the space of a cubic inch, yet being showered down by billions during untold ages, formed a deposit at the bottom of the sea, which being by the forces already referred to raised above the waters in progress of time, formed dry land and the base upon which the whole of the rocks of the tertiary and post-tertiary systems, many thousand feet in thickness, were deposited. These, being denuded by the disintegrating and degrading forces before referred to, form our downs in Sussex and other places, and the removed materials, the *dêbris* of older rocks, made our newer stratified rocks, gravel beds, and deltas, on the surface of which are the alluvial deposits, mineral soils, and vegetable earths forming our agricultural soils.

Of the coral insect, I will only remark that it is still working on a grand scale. Madrepore rocks, which are of analogous origin, altered by heat, are marbles which, when free from impurity, form the statuary marble out of which sprang, under the inspiration of the genius of a Phidias and a Praxiteles, the greatest efforts of art to imitate the human form divine.

Of the Globigerina I wish to add a few words, and I trust I may be excused the digression on account of its marvellous interest.

It will be apparent from the foregoing that our world is an ever-changing scene. Though these changes are effected by slow degrees, they are always tending to a higher and better state, and adapted to a higher order of beings. At first appeared the little eozoon of Sir William

Logan, the oldest form of life as yet recognisable in the rocks; these minute organisms form the mass of the Laurentian limestone in Canada, thousands of square miles in extent and of vast thickness. Then, as the world became fitted for their existence, appeared in due order both in the sea and on the land the various creatures which from time to time have existed. Many forms of life have passed away, and are only known to have ever existed by the testimony of the rocks.

In progress of time there appeared on the earth mosses, then plants and trees, whose seed is in itself; in the air, insects, birds, and flying reptiles; in the sea, zoophytes, annelids, and creeping things, molluscs, and fishes, small and great, with the leviathan also, to take his pastime therein; on the land, soft-bodied molluscs, worms, and creeping things innumerable, the vertebrata, and all the host of them; lastly, man himself, the lord of all, to whom it was given to people the earth and subdue it. He alone, of all creation, was endowed with wisdom and the power to choose between good and evil, and to select the situation for his abode best suited to his health and well-being. He has for his guidance the accumulated experience and wisdom of all men in all ages. If he now neglects the laws of health, and the conditions of sanitary existence, he has only himself to thank for the inevitable consequences.

Whether all the forms of vegetable and animal life, which minister to man's wants and comfort, were the result of separate creations, or the development by evolution from a speck of primitive protoplasm, which chemists tell us is the basis of all living matter, we will not stop to inquire. The votaries of the evolution theory have no real proofs to offer; they admit they cannot show all the links in the chain of evidence; many are wanting, and great are the gaps between them. They show many varieties in species, and claim that, if time enough be granted, all creatures may be accounted for by their theory. But what is time enough? Some important types of life have disappeared, and the only trace we have that they ever existed is the testimony of the rocks in which their remains are found entombed. Indeed, whole districts are formed of their mortal remains; others have existed through many geological eras. What period of geological time would satisfy these evolution philosophers of the nineteenth century? Will the vast period of the world's history, dating from the secondary epoch to the present time? If so, we have direct proof to the contrary. Our eminent philosopher, Dr. W. B. Carpenter, than whom no greater authority on such a subject exists, stated in a recent lecture this impressive fact: that the Globigerina of the chalk sea was still existing, nay, that its actual lineal descendants still live in our seas it is the Globigerina still, and exists in its primitive simplicity unchanged and undeveloped during millions of ages. It was the last form of life found living in the Arctic Seas, by the naturalists of Sir George Nares' recent Arctic Expedition. Certainly, in this case, at least, no evolution has taken place, and the Globigerina of the chalk still lives amongst us the oldest of our aristocracy—a marvellous example of persistence of form in animal life.

Thus far it will be apparent that the changes described have been effected by causes wholly independent of man, by cosmical and other means, and by laws impressed upon the matter of our globe, when, at the fiat of the Almighty, it was first launched into space.

It will, however, be seen in the sequel that many and vast changes have also been and are still being effected by the hand of man, though not always for the better, nor for his own well-being. Much, very much, depends on his acting in conformity with the laws which govern all things terrestrial, though he sometimes violates them from stupidity, or carelessness, or for temporary gain, or perhaps oftener still without consideration, and pays the penalty for so doing.

Having discussed some of the effects of geological change upon the earth, we will next consider how meteorology causes modification of climate, and so produces a distinct effect on health and disease.

METEOROLOGY.

In this short address we can only deal with general principles, and refer outsiders to the interesting volume of our 'Transactions' at Croydon last year, for it is not my purpose to trespass on the domain of the sanitary engineer or the medical and other professors of hygiene. I must, however, call attention to the recent addresses of our distinguished President, who, in his dream of Salutland, points out most of the means by which a healthy existence may be arrived at, the dream being about healthy houses, pure air, and pure water. Here, too, let me express my admiration of the addresses of Captain Douglas Galton, Dr. de Chaumont, Edwin Chadwick, C.B., Dr. Alfred Carpenter, Mr. Alfred Haviland, M.R.C.S., and others.

We have seen how meteorological influences have assisted geological changes in decomposing rocks and forming soils, &c. Let us now see how far they affect climate, and cause some parts to be healthy and others the reverse.

CLIMATOLOGY.

Solar heat is the prime mover and life-giving influence ; it causes winds to blow, which are the great transporting power of the air. By evaporation it raises, in the form of vapour, all the fresh water in the earth to the height of the clouds, and by the winds transports them hither and thither to water the earth, form springs and mighty rivers.

To convert water into vapour or cloud the heat required is rendered latent, and is given out again when the vapour is condensed into water and falls in the form of rain.

How and where this happens is principally due to the distribution of land and water in the various geographical areas, modified by the contour of the land and mountain ranges, and the vegetation and forests on its surface.

Heat is also conveyed from the tropics by ocean currents, and moderates tropical, while tempering arctic climates. For instance, England and Ireland, between the same parallels of latitude as Nova Scotia and part of Greenland, owe their temperate climate to the beneficent influence of the Gulf Stream filling our seas with tepid water, while the prevailing westerly winds, charged with vapour, heated by passing over it, supply our land with fruitful showers, and make Ireland the Emerald Isle of the ocean.

Professor Maury, in his 'Physical Geography of the Sea,' says of the Gulf Stream :—

'There is a river in the ocean. In the severest droughts it never fails, and in the mightiest floods it never overflows. Its banks and its bottom are of cold water, while its current is of warm. The Gulf of Mexico is its fountain, and its mouth is in the Arctic Seas. It is the Gulf Stream. There is in the world no other such majestic flow of waters. Its current is more rapid than the Mississippi or the Amazon, and its volume more than a thousand times greater.'

I have previously reminded you that to convert water into vapour a large amount of heat is rendered latent, which on being condensed into rain gives out the heat so stored up. Captain Maury computes 'that the quantity of heat daily carried off by the Gulf Stream from tropical regions and discharged over the Atlantic is sufficient to raise mountains of iron from zero to the melting point, and to keep in flow from them a molten stream of metal greater in volume than the waters daily discharged from the Mississippi river.' [1]

[1] Maury, *Physical Geography of the Sea*, § 155.

Such is the enormous quantity of heat transported from the tropics, and distributed as a blessing over our native land, giving us fruitful seasons, and filling our hearts with food and gladness.

Viewing the plan of our world, as we find it most complete as regards its meteorology and geography, let us glance at some of the changes effected by the agency of man, both as regards climate and health and the production of food.

Originally, the greater part of the habitable land was clothed with forests, and great and unforeseen changes have often been effected by the indiscriminate clearing of the land by their destruction. Here I venture to copy extracts from an important article on the subject of forests and meteorology recently published in a publication called 'Polybiblion,' which is very instructive, and deserves to be more widely known. The paper gives the results of observations made during the last six years under trees, and not far from the edge of a forest, also in the plain, and far from all trees. It states: '1. Forests increase the quantity of meteoric waters which fall on the ground, and thus favour the growth of springs and of underground waters. 2. In a forest region the ground receives as much and more water under cover of the trees than the uncovered ground of regions with little or no wood. 3. The cover of the trees of a forest diminishes to a large degree the evaporation of the water received by the ground, and thus contributes to the maintenance of the moisture of the latter and to the regularity of the flow of watercourses. 4. The temperature in a forest is much less unequal than in the open, although, on the whole, it may be a little lower; but the minima are there constantly higher, and the maxima lower, than in regions not covered with wood. These observations have been made in the neighbourhood of Nancy, and by the pupils of the School of Forestry of that city, under the direction of M. Mathieu, sub-director of the School. On the other hand, M. Fautrat, when sub-inspector of forests at Senlis, made during four years, but on a different method, observations on forestrial meteorology which fully and completely corroborate, in certain respects, those of M. Mathieu. The laws which seem to follow from the figures given by M. Fautrat, as well as an inspection of the curves which graphically represent them, are as follow:—

'1. It rains more abundantly, under identical circumstances, over forests than over non-wooded ground, and most abundantly over forests with trees in a green condition.

'2. The degree of saturation of the air by moisture is greater above forests than over non-wooded ground, and much greater over masses of Pinus Sylvestris than over masses of leafed species.

'3. The leafage and branches of leafed trees intercept one-third, and those of resinous trees the half of the rain water which afterwards returns to the atmosphere by evaporation. On the other hand, these same leaves and branches restrain the evaporation of the water which reaches the ground, and that evaporation is nearly four times less under a mass of leafed forest than in the open, and two and one-third times only under a mass of pines.

'4. The laws of the change of temperature out of and under wood are similar to those which result from the observations of M. Mathieu. The general conclusion seems to be that forests regulate the function of water, and exercise on the temperature, as on the atmosphere, an effect of "ponderation" and equilibrium.'

The following is from the *Statesman* of June 1 of this year, a review published in connection with the *Friend of India*, Calcutta. First, it appears the plains of India were burnt up, and rendered desolate by the destruction of the forests by invading armies, or to clear more land for agricultural purposes, which led to droughts and floods. Then by the canal system of irrigation, injudiciously carried out, many of the fertile lands of Oude and Upper India have, in a few years, been rendered sterile and salt wastes by the deposit of Reh, a salt perhaps unknown to many of my audience, and frightful famines have been the result:—

'A century ago, Hindostan was a richly-wooded country; but since that time, a variety of destructive agencies have been at work upon the beautiful groves which gave fertility to the soil, and cool and refreshing shade to the people. First in time and in destructiveness were the Mahrattas and the Sikhs. These savage conquerors overran the whole of Central India, of the North-west Provinces, and the Land of the Five Rivers. And wherever they came, they cut down the trees and used them as fire-wood. In this way, some of the most beautifully-wooded districts of India were swept as clean as the palm of a man's hand. Since the country has passed into our possession, though not carried on with the blind folly of savages, the process of denudation has not been stayed. Probably, the work having been done more systematically, and with an object, has also been done more effectually. The enlargement of the area of cultivation has occasioned the clearance of large tracts of woodland. Our railways have been grievously destructive to the trees of India. They have been cut down by the hundred thousand to supply fuel to the engines.'

'Colonel Corbett thus describes the influence of forest lands upon the soil of a country :—

'"Forests and woods preserve moisture in a country in so far as they prevent or retard surface-drainage by their leaves, which fall and form a soft porous carpet on the surface; this, yearly increasing in depth, holds water like a sponge, the lower layers gradually rot and become incorporated with the soil. Thus, in the course of time, there is in every forest (where not carried away by surface-drainage) above the mineral soil a layer of loose humus, the remains of decayed leaves, on which are other layers of leaves in varying stages of decay, the whole forming a mass which freely admits water, and prevents its escape by surface-drainage. The shade of the trees prevents the incidence of the direct rays of the sun; and the trees break the force of the wind, and prevent the surface of the ground being swept and dried by them. Thus forests preserve moisture in the country, firstly, by their soil being in a condition to arrest and retain water; and, secondly, by the trees preventing the incidence of the sun's rays on the surface, and checking the force of the wind; thus, the two chief causes of evaporation are absent." (Pp. 31, 32.)

'It follows in a country like Upper India, where the sun shines with an intolerable heat, and fierce, hot winds sweep across the plains, that the soil, in the absence of trees, will be entirely desiccated. And this evil will be aggravated by the effects of surface-drainage. The clearing of the hill-sides results, necessarily, in bringing down a heavier rush of water upon the plains. This pours over the hardened and desiccated higher lands as it might do over stone or marble, while it floods all the low lands. Thus, the upper lands are sterilised by the absence of moisture, and the low lands are desolated by excess of it. From these causes, according to Colonel Corbett, "the extent of barren lands—lands formerly cultivated, but now producing no crop, save, perhaps, some poor grass in the rains—is yearly increasing."

'The sun beats on these bare, unsheltered plains, and the hot winds sweep across them, drying them up to the hardness of stone. The heat is further intensified by this state of the surface soil, which retains and reflects it as a rock or stone would. The true remedy for this condition of the soil would be a system of deep ploughing. The land thus broken up would absorb and retain a far larger quantity of moisture than is possible for the present glazed surface to do. But deep ploughing, in the present condition of native agriculture, is out of the question. The native cultivators possess neither the draught-cattle nor the plough requisite for deep ploughing. The ploughing of a field in India is little more than a slight scarifying of the surface. If the rains be withheld, the earth literally becomes iron, and defies the puny efforts of the cultivator to prepare it for the reception of seed. Hence arose the notion that if we could cover India with a network of canals, so that every cultivator should have a stream of water brought to his field, we should be independent of the rainfall. The aid which the cultivator requires, in order to break up the soil, would never be wanting to him. There was, of course, a certain measure of truth in this supposition; but the canal engineers, not being agriculturists, were ignorant of the evil latent in their proposed remedy. By irrigation, Colonel Corbett tells us, "the whole surface soil is brought into the condition of sun-dried bricks: the more water that has been applied to the land, the harder the soil becomes; and while its powers of absorption and radiation are reduced, those of reflection and retention of heat are increased; and we also find that the power of capillary attraction possessed by the land is increased, and that the soil so compacted will sooner become dried up than soil left loose and open." As an illustration, he describes what takes place in a field of wheat, duly irrigated, but the extract is too long to quote.

'Thus, the direct and inevitable effects of canal irrigation are evil in every way. By hardening the soil they diminish its productiveness; and yet the cultivator is driven, by the fact of this hardening, to depend upon this poisonous agency before he can, in the absence of the rain, prepare the soil for cultivation at all. In other words, by the extension of canal-irrigation we obtain a temporary and precarious advantage, at the cost of the permanent sterilising of the soil.

'But worse, far worse, than any of the evils we have yet enumerated as the consequences of irrigation, is the production of what is called *Reh*, which follows in the wake of our canals like black care behind the horseman. So far back as 1850, the officiating superintendent of the Western Jumna Canal, in forwarding to Calcutta some samples of *Reh* for analysis, wrote thus:—

'"The attention of the Civil and Canal Authorities in these parts has, for a considerable period, been directed to a change which is taking place in the soil in various parts of the country irrigated by these canals. A white efflorescence has made, and is making, its appearance in various places, destroying all vegetation with which it comes in contact. The barren space gradually increases in area, and speedily the ground thus affected is deserted by the cultivators, who forthwith assail the civil officers with petitions for remission of revenue."

'In the twenty-eight years which have elapsed since the foregoing was written, there has been a most appalling extension of *Reh* in the canal-irrigated districts of the North-west Provinces. In 1874, a canal officer records his opinion in the following emphatic language:—

'"Canal water creates *Reh*, especially when it runs above the surface of the ground-level. It is with canal-water that the disease is propagated. The canal, in its passage through *oosar* lands, drains off the saline matter in the *oosar*, and deposits it elsewhere. *Three to seven years is the time required to poison the land, and the Reh to show itself.* No physical law governs the character of the land in which *Reh* appears. It is only necessary to irrigate good land with poisoned water for four or five years to propagate *Reh*."'

Other notable instances of change of climate are those of the Holy Land and part of Asia Minor respectively. Thus Mr. Geo. P. Marsh, in 'The Earth as Modified by Human Action,' page 450, says:—

'The summers in Egypt, in Syria, and in Asia Minor, and even Rumelia, are almost rainless. In such climates the necessity of irrigation is obvious, and the loss of the ancient means of furnishing it helps to explain the diminished fertility of most of the countries in question. The surface of Palestine, for example, is composed in a great measure of rounded limestone hills, once no doubt *covered with forests*. These were partially removed before the Jewish conquests, when the soil began to suffer from drought, and reservoirs to retain the waters of winter were hewn in the rock near the tops of the hills, and the declivities were terraced. So long as the cisterns were in good order and the terraces kept up, the fertility of Palestine was unsurpassed; but when misgovernment and foreign and intestine wars occasioned the neglect or destruction of their works, traces of which still meet the traveller's eye at every step, when the reservoirs were broken and the terrace walls had fallen down, there was no longer water for irrigation in summer, the rains of winter soon washed away most of the thin layer of earth upon the rocks, and Palestine was reduced almost to the condition of a desert.

'The course of events has been the same in Idumæa. The observing traveller discovers everywhere about Petra, particularly if he enters the city by the route of Wadi Ksheibeh, very extensive traces of ancient cultivation, and upon the neighbouring ridges are the ruins of numerous cisterns, evidently constructed to furnish a supply of water for irrigation. In primitive ages the precipitation of water in these hilly countries was in great part retained for a time in the superficial soil, first by the vegetable mould of the forests, and then by the artificial arrangements I have described. The water imbibed by the earth was partly taken up by direct evaporation, partly absorbed by vegetation, and partly carried down by infiltration to subjacent strata, which gave it out in springs at lower levels; and thus a fertility of soil and a condition of the atmosphere were maintained sufficient to admit of the dense population that once inhabited those now arid wastes. At present the rain water runs immediately off from the surface, and is carried down to the sea or is drunk up by the sands of the wadis; and the hillsides which once teemed with plenty are bare of vegetation and seared by the scorching winds of the desert.'

The following appeared in the 'Daily Telegraph,' September 7, 1880:—

'In consequence of the reckless and extravagant felling of timber that has prevailed throughout Western Russia during the greater part of the present century, several of the streams feeding the Dneiper have become dried up, whilst others contribute so little water to the great river that its navigation has already suffered serious prejudice, and is, in some portions of its course, threatened with absolute interruption. Rocks and sandy islands in great number, forming sections of its bed, may now be seen where a few years ago from twelve to fifteen feet of water hid them from view. As the Dneiper traverses and largely contributes to the prosperity of no fewer than nine Russian provinces, or "Governments," this falling off in its dimensions and capacities is in reality little short of a national calamity, for which, however, Russian landowners and the Mir have only to thank their own ignorance and improvidence.'

NOXIOUS TRADES.

Dr. Richardson's dream of a Salutland in last year's address consists mainly of ideal, healthy, well-drained, well ventilated houses with plenty of pure air, pure water, and wholesome food.

To obtain all these blessings is the object of Sanitary Science and Sanitary Legislation. Each division of the subject has been already so well and ably treated by master minds, that I will not venture to add to what has been advanced by them, but I will say a word or two on the result of modern sanitary legislation, which has to a great extent failed in its object. It is a notable example of how not to do it, for it places the power of dealing with and abating nuisances mainly in the hands of those who create them, and it is only in very serious cases, with great difficulty and expense, that public opinion is able to compel local authorities to put the Acts in force. These public authorities seem to be under no responsibility; they consist mainly of officers appointed and removable by the large ratepayers, who, some of them being manufacturers carrying on noisome trades and *living at a distance*, think more of saving the rates and less of the health or comfort and happiness of the populous neighbourhoods cursed by their unwholesome factories. They seem to be under no obligation to carry on their works with the *least* possible injury to their neighbours, and often neglect the means afforded by science of doing so, frequently to their own loss. If they were compelled to either abate the nuisance or remove their factories, they would soon find the way to do it! The question is one of saving expense in altering plant, and adopting improved processes. It is well known that necessity is the mother of invention. Waste products chiefly create the nuisance, and ought to be utilised and made a source of profit, instead of poisoning the air we breath or the water we drink. For example, the obligation imposed on the makers of gas of getting rid of gas refuse led to the invention of aniline dyes, from which splendid fortunes have resulted; and many other instances might be adduced.

The whole mischief of noxious vapours being driven off into the atmosphere might be avoided if only the vicious system of permissive legislation were changed, and the law compelled the authorities, however appointed, to put the law in force, and held them, not only collectively but individually, personally responsible by fine or imprisonment for neglecting their duty. Especially Sanitary Inspectors and Medical Officers of Health, I submit, should be appointed by the State, but however appointed, they should be protected by it in the performance of their duties. As it is, the members of local boards, in view of re-election by ignorant ratepayers, think more of saving the rates than the health of the neighbourhoods adjoining and surrounding; and the air is often polluted for miles by their neglect. Their interest would seem to be *laissez faire*—which reminds me of the advice given by that crafty old statesman Talleyrand to a young aspirant for promotion, who had shown too much anxiety to do his duty, 'Avant tout, mon ami, point de zèle!'

I have the misfortune to live in the far east of London. When I was a young man and first came to live there, more than forty years ago, ours was a suburban village, and the population of the whole parish was under 10,000. By the improvements in London, and the removal of the dens of St. Giles, the City, Shoreditch and Whitechapel, the population has been driven east, and West Ham is now a town of more than 120,000 inhabitants, daily increasing. It has also become a new centre of industry, and, by the formation of magnificent docks, a very important part of London. The Metropolitan Board, having regard to the metropolis only, drove the filthy factories of Bow Common over the border (that is, the River Lea) into Essex. They took refuge in the adjoining parish, West Ham, where, in the midst of a crowded population they carry on their noisome trades with impunity, mainly owing to the protection given to them by the curse of permissive legislation. Why should not animal charcoal makers, artificial manure makers, blood boilers, chemical works, and other kindred trades (if allowed at all to come into populous places) be compelled to use retorts or other means which science could point out to remedy this state of things? When the wind sets our way we cannot open our windows without being covered with smut, or sickened by filthy smells, especially at night, which is a great misfortune in sultry weather.

We cannot even get the Smoke Acts adopted, and our town is becoming the *beau ideal* of a Black Country.

An article in 'Household Words,' edited by the late Charles Dickens, published September 12, 1857, did much good in calling attention to the dangerous state of parts of West Ham for want of proper drainage. A providential attack of cholera was the cause of drainage works on a large scale being carried out. They have been a great blessing, and why should not the Local Government Board again interfere, and, by an amendment of the law, drain our atmosphere from pollution? The law protects our property and our liberties, why should not our health and lives be equally the care of our legislators?

HEALTHY HOUSES.

In regard to our houses too much care cannot be taken to have them built on dry soil. Our streets should be laid out as far as practicable in the direction of the prevailing winds, that they may blow through them. The walls should be built of suitable materials, and of sufficient thickness to be warm and dry. The rooms should be carefully ventilated, and the sanitary arrangements should receive the utmost attention of the architect. The local surveyor also should see that the drainage and water supply are properly attended to. In no case should the same cistern be used for drinking purposes and sanitation. Water absorbs gases, and the overflow pipes from cisterns should never discharge into closet traps, as is too frequently permitted; nor into cesspools. All such pipes should discharge over properly trapped sinks with a space of several inches of air between them, so that no connection exists between the discharge pipe and the receiving sink.

WATER.

All the fresh water in the world has been distilled from the sea, and transported in the form of clouds and vapour to water the earth. The largest lakes or inland seas, the most mighty rivers, and all springs and fountains, owe their origin to this source.

Where rain falls depends on meteorological causes and on the contour of the land, its forests, and the prevailing winds. Thus, on the eastern side of the Andes, the heavily-laden clouds coming from the tropics and the Atlantic are precipitated more or less according to the nature of the soils, the vegetation, and the districts they pass over, until, crossing the upper ranges of the lofty chains of the Andes, above the limit of perpetual snow, every particle of vapour forming the clouds is condensed, and, so to speak, every drop of water is wrung out of them; they are practically destroyed. Consequently on the western slopes there is a cloudless sky, rain is almost unknown, and what vegetation there is is supported by nocturnal dews, which are drawn from the adjacent water of the Pacific Ocean.

Thus on the east of the great mountain range, the heavy rains caused by the condensation of the clouds give rise to lakes and inland seas and mighty rivers, some of which flow for thousands of miles through alluvial plains, destined henceforth to grow corn, and feed cattle for the food of older inhabited and more densely populated lands, which, like England in the present day, are quite unequal to grow sufficient food for themselves.

The same thing, on a smaller scale, takes place in our own country. The clouds travelling over the warm water of the Gulf Stream, a branch of which impinges on our shores, are precipitated by the mountains and high lands of Ireland, Devonshire, Cumberland, Westmoreland, and Scotland. On the west side, therefore, of these ranges there is an abundant rainfall. At Seathwaite, under Seatollar, it is sometimes as much as 179·12 inches.

The wettest spot in England is the Stye, half a mile from Seathwaite, in Borrowdale, at the south end of Derwentwater, and 1,077 feet above the sea. The mean fall there is 175 inches; at Seathwaite, about 600 feet lower, and half a mile off, 140 inches; while at Keswick, about ten miles off, it is only 60 inches.

All along the west coast, Penzance, Pembroke, Lancashire, West of Ireland, Dumfries, and the flatter parts of the West of Scotland the rainfall is 40 inches, but is more where the ground is hilly.

The mean rainfall of—

All Cumberland is about	60 inches.
„ Westmoreland „	55 „
„ Northumberland „	25 „
„ Durham . . „	25 „
„ Eastern Counties, about	25 „
„ London (Greenwich) 1841 to 1879 . .	24 „

while at the driest spot in England (near Bedford) it is only about 22 inches.*

It is obvious from the foregoing that more water cannot be drawn from any watershed than falls as rain within it; and even all this is not available, for much runs off direct into the rivers, and flows again to the sea to be re-distilled and re-distributed, while the remainder sinks into the soil.

The Royal Commission appointed to inquire into the future sources of pure water for London and other large cities, have accurately mapped out all the various watersheds, and calculated the rainfall in each. The report of these able men, drawn up, I believe, by my friend, Joseph Prestwich, F.R.S., F.G.S., the Oxford Professor of Geology, and one of the ablest geologists living, has exhausted the question of whence London and our other large cities can derive abundant supplies of pure water. It will be for Parliament to choose from amongst the many schemes proposed that which, in their wisdom, after due inquiry, they may deem the best, and to pass the necessary Acts to enable our sanitary engineers to carry out this great object. Where the local watersheds cannot supply the required quantity, it is clear it must be brought from a distance.

Smaller towns and villages may be supplied by the way. And when Parliament shall have seen fit to provide the means for enforcing the law against the pollution of the streams and rivers made by nature for the benefit of all, it is hoped that at no distant date all our streams and rivers may afford the local inhabitants a supply of reasonably pure and wholesome water. It has been shown in the section on Geology how, by the breaking up of the older rocks, new combinations have been formed, and beds of sand and gravel deposited with water-bearing strata on impervious ones. These sands and gravels are the great natural filtering beds to clear the water of our springs

* I give this on the authority of my friend Mr. G. J. Symons, F.R.S.

and wells from any impurities it may have contracted in passing through the surface soils. Thus all has been preparing for the welfare of man, and for providing him with pure water, one of the first necessaries of life.

I fear I have exhausted your patience. Yet I have tried, as far as I could in the short time allowed for this address, to show that, from the earliest history of our globe, geology, meteorology, and the kindred sciences prove to demonstration that this world of ours has been prepared by laws given by Almighty wisdom to fit it for the well-being of the creatures destined to inhabit it, and that the hand that made it is Divine. There are tongues in trees, books in the running brooks, sermons in stones, and good in everything.

SEWAGE.

Mr. Haviland, whom I have before quoted, has well said that sanitary science ought not and does not consist in expedients for correcting the fault of others; we ought to go to the root of matters, and not first poison our rivers with manufacturing refuse and the sewage of large towns, and then again pay millions for guano to fertilise our fields and replace the sewage, while we pay millions more to construct sewers to convey it to the sea in utter waste, instead of using it to produce grass and grain for food, and to prevent our fields from becoming sterile by over-cropping, like the Campagna of Rome, once the granary of Europe. Obviously there should be returned to the soil what we take out of it, or its equivalent, which is the object of manuring.

Sewers, under the circumstances of large communities aggregated in small areas, huddled together in towns, built without any previous plan or regard to sanitary arrangements, are a necessity; for the land around large cities is not capable of chemically deodorising or purifying such prodigious quantities of sewage as are daily produced, together with the volume of water used to carry it. It would infallibly soon drown the land with the sludge, which would stagnate, putrefy, and generate malaria. Nature's laboratory—the soil and atmosphere—in such case would be unequal to oxygenate and purify either the solid particles or the water used to carry it. This is the great danger in over-tasking sewage farms. Chemistry always acts by equivalents and in definite proportions, and we must not attempt impossibilities or sin against natural laws. In such a case we must submit to the lesser evil of sewers, which are nothing more or less than elongated cesspools. These, for convenience, we connect with our dwellings; and we must do our best to keep the sewer gas out, first by ventilating the sewers and making them as far as possible self-cleansing, so that no accumulating pressure of gas shall force its way in. This is certain to happen if flood waters or waters used for flushing cannot more freely escape otherwise. At best a trap is only closed by the weight of two or three inches of water, which pent-up gases, often equal to a pressure of thirty inches, can easily displace, and then there is direct communication with the inside of our dwellings. In the first place we must look to our engineers for the most scientific form of traps they can furnish, and then see them fixed efficiently by skilful plumbing. Great danger and vast mischief have arisen from bad traps and defective plumbing. Mr. Eassie, C.E., one of our Council, did great service to sanitation at the Exhibition at the Croydon Congress, last year, by exhibiting traps which were defective, or had become so by corrosion in use, and which did deadly mischief before the cause was discovered. Rats also frequently burrow into the cellars and make free vents for sewer gas. It is feared that many fever dens exist from similar defects to those shown. Much, however, may be done to lessen the inherent danger of sewers by ventilation and constant flushing. Fresh sewage does no harm, unless fermenting or contaminated by the emanations, whether germ or gases, from fever or other contagious diseases, which, under certain circumstances of heat and fermentation, if not multiplied, are, at least, often conveyed by the sewers. What the nature of contagion and infection is, whether by germs *sui generis* or otherwise, is not yet thoroughly known or understood, but, I believe, the favourite theory of some eminent medical men is the germ theory. This I know is disbelieved in by others equally eminent; and who shall decide when doctors disagree? Dr. William Proctor, in his valuable treatise on 'The Hygiene of Air and Water, the Effects of their Impurities, their Detection, and the Modes of Remedying them' (London: R. Hardwicke, 1872, p. 67) says:—

'If it be true, as modern science has almost demonstrated, that the real agents of such diseases as infectious fevers, cholera, rinderpest and other allied (zymotic) affections are living germs and not a gas, or vapour, or dead organic matter, it becomes a physiological rather than a chemical question to decide on the best means fitted for their destruction. That which has been proved in respect of small-pox and other allied diseases is very applicable to the present inquiry so far as it relates to the most probable existence of germs in the water we may drink. The agents, then, of these diseases, it is believed, are living germs, capable of remaining dormant for an uncertain but not indefinite time, and then springing into activity when they find the conditions requisite for their development. But whether these germs are capable of destruction by oxidation in the atmosphere or water is an unsettled question. We do, however, know that these germs are destroyed by a high temperature, that they are killed by a large number of caustic substances, and that they cannot resist the action of certain agents, such as carbolic acid, which act on them as specific poisons. Therefore to this class, rather than to oxidising agents, we look for their removal. And in the case under consideration, the reliable agent is heat.' [This agrees with my late dear friend Dr. Crace Calvert's experiments, but he found that a very much higher temperature than boiling water was necessary to destroy them. *Vide* 'Transactions of Royal Society.']

Then as to the ultimate disposal of sewage. It must no longer be allowed to pollute our rivers, poison our drinking water, breed fever, and destroy our fish. We can do something to mitigate the mischief. We can precipitate and deodorise the solid matter by the aid of proper agents and intercepting tanks, and thus render the effluent water sufficiently harmless to justify its return to our streams and rivers, where the current is sufficiently strong to dilute it, so that the oxygen of the atmosphere, vegetation, and animal life may in turn purify it in nature's laboratory, and render it again fit for use. I know not how, with my present limited knowledge of chemistry, the salts of sewage in solution can be got rid of; and, to say the least, it is a filthy idea, that water, if ever impregnated or any way contaminated by sewage, or by passing through cemeteries, should be allowed to be supplied to our cities by water companies who take their supplies from polluted rivers. However bright and sparkling to the eye water may appear, if it contains any trace of sewage in solution, it is not fit for the use of man. In all cases of doubtful water, it should be boiled, left to cool, and be filtered through animal charcoal, which will eliminate a large portion both of organic or mineral impurities.

For small communities and villages with plenty of dry earth to be had, and fields and gardens for its disposal, any attempts at sewers would, I submit, be inexcusable; they would never be kept in order; and under proper regulations earth closets seem the natural remedy. They have even been adopted with success in some large towns in the north. But doubtless the disposal and utilisation of sewage and a pure water supply are the great sanitary problems of the day.

MARSH FEVER.

I have lately been reading an exhaustive work of great research by Dr. Macculloch, published in 1827, on the production and propagation of malaria, which deserves to be better known and studied than it is. It contains some sound advice and some startling facts. The doctor proves that, in all parts of the world, the same causes produce the same effects, and that drainage, cleanliness, and ventilation are the sovereign remedies.* He conclusively shows that decaying vegetable or animal matter under a hot sun in damp soils, swamps, or swampy stagnant pools, however small, is capable of generating the poison of malaria in sufficient quantity to poison those who inhale it, and cause fever which is often mistaken for, and treated as, typhoid. Many examples are given. The source of the poison is well known, but what that poison is, or how generated, our chemists have not yet been able to determine. Without going to Indian jungles, tropical rice-fields, or African swamps for examples, we have the melancholy fact that some of the fairest portions of the earth have, in all ages, been suffering from it in those parts where drainage has been neglected and natural swamps exist, especially on river banks.

Need I name Italy, with its Roman or Pontine marsh fever, and Greece? and this in spite of warning and the accumulated experience of ages, though the remedy, drainage, has been well known from the earliest time of which we have any record. Mr. Haviland writes, in a recent paper of his, read at Croydon (see page 193, vol. i., of our 'Transactions'):—'Hippocrates, who lived between two and three thousand years ago, was a physician and the founder of medicine. He was in advance of the age in which he lived, and, in many things, in advance of that in which we live. This extraordinary man lived at a time when there were, as contemporaries, some of the most brilliant men the Greek Isles ever produced. He taught, at that remote period, how necessary it was to study the nature of the soil in relation to disease, the qualities of the water which either sprang from it or had flowed over it. He laid down certain rules, which are applicable now to the same locality wherein he practised, as to the selection of sites, &c.; and he wrote a philosophical treatise on airs, places, and waters, which may be read now with advantage, and especially by those who think there is nothing like the learning of the nineteenth century, for they will there see clearly and distinctly shown, that diseases have a geographical distribution, and that the soil on which a man lives must be studied by the physician who would wish to combat successfully with disease.

'The graphic description of the effect of the swampy country around

* Mr. Dunnage tells me that in all his experiences in New Zealand swamps he never heard of a case of fever or malaria.

the river Phasis on the dwellers there, shows how keenly he observed and how highly he appreciated the facts which nature pointed out to him on the bosom of mother earth. Hippocrates well knew that, whilst the crust of the earth remained as it was in his day, whilst there were deltas, swamps, and lagoons exposed to the heat of the sun, that disease would arise; and that, unless these spots were pointed out by the physicians, men would heedlessly settle there, and in the sequel pay the heavy penalty of ignorance, which we are doing every day. All this knowledge had been gathered, digested, and sent forth, in the most choice language that man could write, centuries before the Christian era; and yet we are, in this our boasted nineteenth century, piling up statistics, binding them in blue covers, placing them on our shelves, and converting these volumes that contain them into simple dust collectors. I say this is humiliating, and certainly does not encourage us in believing that the efforts which sanitary institutions are making now will be followed by the anticipated success, at least in this country.' And here let me pay my willing tribute of respect to the zeal and ability with which Mr. Haviland in his work has followed the teaching of his great master.

Dr. Macculloch conclusively shows that in our country some small spaces are sufficient to generate this poison, and cause fever where least expected, though, of course, in large districts, such as the Fen Country, it is more prevalent and more virulent. It occurs more or less on the marshy banks of our own rivers; and the Essex marshes on the banks of the Thames are not free from its dire effects. The 'Times' of October 8, 1879, had the following interesting account of the poison of marsh fever, which shows a laudable attempt to discover its nature :—

'THE POISON OF MARSH FEVER.

'The physical cause or poison to which marsh or intermittent fevers are due, was made the subject of special investigation during the spring of the present year, by Signor Tommasi, Professor of Pathological Anatomy at Rome, in conjunction with Professor Klebs, of Prague. According to an account laid by the former before the Academy of Rome, the investigation was rewarded with complete success. The two investigators spent several weeks during the spring season in the Agio Romano, which is notorious for the prevalence of this particular kind of fever. They examined minutely the lower state of the atmosphere of the district in question, as well as its soil and stagnant waters; and in the two former they discovered a microscopic fungus, consisting of numerous moveable shining spores, of a longish oval shape, and a micro-millimètre in diameter. This fungus was artificially generated in various kinds of soil; the fluid matter thus obtained was filtrated and repeatedly washed, and the residuum left after filtration was introduced under the skin of healthy dogs. The same thing was done with the firm microscopical particles obtained by washing large quantities of the surface soil. The animals experimented upon all had the fever with the regular typical course, showing free intervals, lasting various lengths of time up to sixty hours, and an increase in the temperature of the blood during the shivering fits up to nearly 42 degrees, the normal temperature in healthy dogs being from 38 degrees to 39 degrees Centigrade. The animals artificially infected with intermittent fever showed precisely the same acute enlargement of the spleen as human patients who have caught the disease in the ordinary way. And in the spleens of these animals a large quantity of the characteristic form of fungus was present. The fungus was also found abundantly in other lymphatic vessels of the animals. As the fungus here grows into the shape of small rods, Tommasi and Klebs gave it the name of Bacillus Malariæ. The strictest scientific method pursued in this investigation does not admit of a doubt that the accomplished investigators have really discovered the real cause of the disease in question. The discovery may be regarded as another of the series of which those in connection with inflammation of the spleen and diphtheritis were earlier examples. Against the intermittent fever poison, which is connected with this newly discovered microscopic fungus, the medical art was formerly as powerless as it still is against diphtheritis and inflammations of the spleen. For intermittent fever, however, medicine was provided with a remedy, when the virtues of quinine were made known, and it may be reasonably expected that, as in the latter case, so against the poison of the diphtheritic fungus and that of splenetic inflammation, medical science will sooner or later discover their appropriate antidote. Further particulars of the experiments and discovery of Tommasi and Klebs will be found in the July number of the "Zeitschrift," edited by Professor Klebs.'

Towards the beginning of the sixteenth century a very terrible malady made its first appearance in this land. The origin of the evil, called Sudor Anglicanus, was at that time supposed to be wrapped in mystery. The disease popularly known as the sweating sickness was looked upon as one of those visitations which have so often been attributed to an offended Providence, instead of to the true cause of their existence. Illumined by the light of modern teaching, we can entertain but little doubt that the dreaded sweating sickness, which created such havoc in the reigns of Henry VIII. and his son, was entirely due to the almost Eastern condition of things then apparent in our system of drainage and ventilation, such as it was in those days. The houses even of the great harboured filth and dirt, which were allowed to remain unremoved, and thus to exhale their noxious gases with fatal freedom. The narrow streets were the receptacles for all garbage, whilst open sewers slowly rolled their contents towards a polluted river, which became continually more polluted still. Pure water for drinking purposes was scarcely to be had. The brewers, it is stated, monopolised the springs for their trade, whilst the conduits, which even a century before had been insufficient for the wants of the people, now simply mocked at the requirements of the town. Meat it is stated, was cheap, and the English people notorious for their robust appetites. It is not, therefore, surprising that men breathing in their own homes, and out of doors, a fœtid atmosphere, with their blood heated by heavy consumptions of animal food, should fall easy victims to a pestilence which their own offensive habits had helped to engender and encourage.

ATMOSPHERE.

In treating of the geological part of our subject, I have spoken of the sea, but it is to be observed that our planet is invested with *two* great oceans—one visible, the other invisible; one entirely envelopes it, and at the bottom of this we live; the other covers two-thirds of its surface. All the waters of the one weigh about 400 times as much as all the air of the other. We used to speak of the sea as unfathomable, but, by modern improved instruments, it is ascertained that the greatest depth is from four to five miles, which is about the height of the loftiest mountains above the sea; whilst the shoreless aërial envelope, the great laboratory of nature—the atmosphere—is about 50 miles high; but air being a highly elastic fluid, it is impossible to obtain its exact depth. If the air were a non-elastic fluid like water, we could ascertain the height of the atmospherical ocean with the barometer, and gauge it by its pressure, but, owing to its elasticity, the lower strata are pressed down by the superincumbent air with a force of about 15 lbs. to the square inch, while those at the top are inconceivably light, and at the top of high mountains it is so attenuated that it is difficult to breathe. Chemists who have made the analysis tell us that, out of 100 parts of atmospheric air, 95·5 consist of oxygen and nitrogen, mixed in the proportion of 21 of oxygen to 79 of nitrogen by volume, and of 23 to 77 by weight; the remaining half part consists of 0·5 of carbonic acid and ·45 of aqueous vapour. Mixed with these there is generally a minute quantity of ammonia, and a small portion of oxygen in a highly electrical state, to which Schönbein gave the name of ozone.

The importance of ozone in the economy of nature has only quite recently been ascertained and appreciated. During the thirty years which have elapsed since the famous researches of Schönbein, ozone has been studied by some of the most illustrious scientific men of the century. The most recent work on the subject which has come under my notice is by Dr. Cornelius B. Fox, and it contains a resumé of all that was known up to the date of its publication in 1873.

Schönbein, in his work on the action of oxygen (the life-giving principle in the air), expressed his opinion that the blood globules, like phosphorus, are endowed with the property of chemically polarising the oxygen of the air with which they are brought in contact in the lungs, and of thus splitting it up into ozone and anti-ozone. I must not, however, quote further, but refer my hearers for full particulars to the many learned treatises on the subject, which treat of the abstract principles of experimental chemistry. All I can add about it here is, that it is believed to be the chief oxidising principle of the air we breathe, and is one of the chief agents by which the many impurities contracted by air and water are removed altogether, or changed into harmless oxides.

Breathing consists of two acts, viz.: inspiration or taking into the lungs pure air (when it may be had), and expiration, or expelling it again from the lungs in an impure state—for, by the act of breathing, it is deprived of its vital oxygen, which is replaced by carbonic acid, accompanied by a variable quantity of organic substances, consisting of fatty matter and particles of epithelium or skin, estimated for an adult at as much as 30 to 40 grains a day.

This is the cause of the disagreeable odour of close and crowded rooms. The watery vapour given out in respiration, laden with these impurities, condenses on the walls of confined and ill-ventilated bedrooms and buildings, is condensed, and trickles down in fœtid streams. Hence the absolute necessity of ventilation if we wish to enjoy a healthy home.

One means of preventing the air becoming continually more impure by the gases discharged into it, is the chemical law of diffusion, by which they are diluted and carried away by the wind, which substitutes a fresh supply of pure air.

When the air stagnates, whether in mountain valley, or in closely shut rooms, or in crowded courts and alleys into which a breath of air or gleam of sunshine can scarcely enter, there can be little wonder that disease and death are the result.

The legislature has passed Acts for the purification of the atmosphere of smoke and noxious vapours, but has not taken measures for putting these Sanitary Acts in force. Nature is more beneficent, and by the aid of winds does much to remedy the pollutions made by man, by diluting them by ventilation on a grand scale; and we ought to see that no impediment is laid in their way.

Falconer, in his beautiful poem, 'The Shipwreck,' makes the pious sailor say :—

> Perhaps this storm is sent with healing breath,
> From neighbouring shores to scourge disease and death;
> 'Tis ours on thine Almighty Wisdom to rely,
> Thy mercy supplicate if doomed to die.

Rain also has a beneficial influence in washing out many of the more solid impurities floating in the air, and we Londoners welcome a heavy rain to wash our dirty streets, and clear away a London fog, which is mainly smoke, and ought economically to be burnt, and not mixed with the damp and vapour of a winter's day. Rain also washes out of the atmosphere the ammonia suspended in it, and assists greatly in fertilising the soil. Snow has a similar beneficial effect.

In all the books on ventilation, I find reference is made to the dreadful tragedy at Calcutta, when 146 people were shut up in what was called the Black Hole, and in the morning 123 were found to be dead, and others dying. That is an extreme case, but too much stress cannot be laid upon the necessity of ventilating our houses, and it has been well remarked, that we have too many Black Holes from overcrowding and closely shut-up bedrooms. Sometimes a broken window is a positive blessing, and it is a good precaution to lay out streets in the direction of the prevailing winds, that they may blow through them as much as possible.

A man consumes the vital principle of a gallon of air every minute, and a candle or lamp burns the oxygen of the air in proportion to the size of its flame, and, if placed under a receiver, is extinguished as soon as the oxygen is consumed.

A ready mode of ascertaining the amount of carbonic acid thrown off from our lungs is by breathing through a tube inserted into clear lime water; the water soon turns milky, and the lime is thrown down in the form of a carbonate.

Need more be said to enforce the necessity of ventilation?

BAD FOOD AND JEWS.

Bad food, and especially diseased animal food, as well as unripe or decaying fruit, is the cause of many serious illnesses, which our physicians find it difficult and often impossible to grapple with. Too great severity cannot be visited upon those villains who knowingly sell diseased meat, poultry, or fish. The immunity of the Jews from scrofula is a great fact. They are forbidden by their law to eat the foul animal. The pig (*sus scrofa*) is the principal—nearly the only—animal food of the inhabitants of the Western prairies. Scrofula (from *sus scrofa*) I learned when in America was the cause of much suffering from that sad disease. It is first cousin to consumption, which is terribly fatal in the United States.

The following extract from the 'Ecclesiastical Review' of July 31, 1880, fully bears out the above experience, and is a very remarkable testimony in favour of carefully-selected animal food, it being well-known that the chosen people only eat food killed by their priests, after careful examination, and that any beast discovered to be in any way unhealthy, or found to be in any way defective, is discarded, or more probably sold to Christians, who are not so particular :—

'What he (Dr. Thring) states as to the survival of Abraham's children is very interesting, and fully borne out by vital statistics as well as by Scripture prophecies. A Jew's life (he says) is found on an average to be worth fifty-seven years in duration, whilst a Christian's in the same country is only worth twenty-seven, or less than half as much. Dr. Septimus Gibbon, speaking at the Pathological Society of London, in 1876, said :—"The Hebrews of the metropolis are notoriously exempt from scrofulous and tubercular taint. During the last twenty-five years I have attended a large number of Hebrews, both as hospital and private patients, and have never met with a single case of pulmonary consumption amongst them; and a former colleague at the London Hospital, who had a large *clientèle* amongst this favoured people, told me that for forty years he had only met with two cases. The medical officer of one of their large schools has remarked that their children do not die in anything like the ratio of Gentile children; and in the district of Whitechapel the Medical Officer of Health has reported that on the north side of the High Street, occupied by Jews, the average death-rate is 20 per 1,000 inhabitants; whilst on the south side, occupied by English and Irish, it is 43 per 1,000."'—('Trans. of the Pathological Society,' vol. xxvii., p. 437.)

ANTONIO BRADY, F.M.S., F.G.S.

The BISHOP of Exeter, in proposing a vote of thanks to the President, said he did not think it was possible to have listened to his address without feeling more and more interested. There was a great deal in it for after consideration. The lecture contained a great deal of that which was altogether new to the majority of them. It was impossible that they could have listened without interest to the causes to which were attributed the famine in India. Scientific men had done much for good and evil, for scientific men had made mistakes, and there still remained a great deal for science, with caution, to do. He did not propose to criticise the irrigation system of India, but they must all feel an interest in their fellow-men, and could see the value of a better application of scientific principles to these matters. He did not think it was possible to abstain from expressing their gratitude to one who had given them such valuable information, and he hoped it would stimulate those who had listened to it to the scientific investigation of these matters in the interest of human life.

Mr. RAWLINSON seconded the motion. The paper was so discursive that it would be impossible to attempt to deal with all its points. With some of the opinions expressed he agreed, but he must confess that there was a considerable portion of the opinions expressed on the paper with which he did not agree, and it would be hopeless for humanity if they were true. They had heard a great deal about tree-planting. No doubt tree-planting did modify the climate, but, unquestionably, it did not in any great feature change it; and when they heard that springs and rains were caused by it he looked upon the statement with great hesitation. They had also heard of malaria. Very few men had had the opportunities of considering what was called malaria that he had had, and he had come to the conclusion that in the vast proportion of these cases the cause of mortality was not the earth or the climate, but the filthy habits of the people upon the surface. Climate was not so deadly a thing as even scientific men supposed. He would give them an instance. Before he went out to the Crimea he read Dr. Clark's Travels, and was there told that in the Crimea fevers were the great cause of complaint; that if you were exposed to the morning sun you were liable to fever, and that if you were exposed to the evening dews or drank the water you were liable. When he got there what did he find? The Government had sent out the finest army that had ever left our shores—seasoned men in the maturity of health. They knew how shamefully our soldiers were neglected, and how they were kept under conditions in which life was sacrificed to a shocking degree. There were British regiments there that in three months lost 700 men out of 1,000. He did not wish to take credit to himself, but the Government of that day selected him and certain medical gentlemen to go out to the great hospitals on the Bosphorus and in the Crimea, and see if it was possible to modify that state of things. At the same time a Commissariat Department was sent out, and, public indignation being aroused, all sorts of relief despatched, and therefore the Sanitary Commission could not take all the credit: but he maintained that they did good they did not receive credit for. Instead of the climate of the Crimea being the deadly one represented, after their arrangements were carried out the soldiers were in a better position than they were in their own barracks at home, although they were exposed morning and evening.

Dr. Richardson said the address had brought forward Colonel Corbett's report, and if that should turn out to be true nothing would be more remarkable. The statement in it was that the canal system in India had been an utter failure, and that if the process went on the whole of the irrigated part of India would be soon a sterile desert. He knew that if his friend Colonel Cotton was present, he would declare that this was not the case. He mentioned this to show that this matter was controverted. He himself had tried to get at the facts through the natives, but their accounts were very contradictory.

Sir Antonio Brady, in responding, said that he must not be held responsible for all that was in his paper. He should not have quoted as he had unless he had believed in what was written, but as he had not been able to verify the statements, he had given his authority for them. His desire was that this matter should be discussed.

Observations on the Geology of Exeter, and the Improbability of there being a Subterranean Water Supply for Economical Purposes.

In consequence of an alleged insufficient supply of water from its source in the Exe for the City of Exeter, the Corporation, about two years and a half ago, purchased the Water Works from the Company, in order that such alterations and additions should be made as might from time to time be considered necessary. Since then the possibility of a sufficient subterranean supply has been frequently discussed in the local newspapers. It has been argued that inasmuch as Exeter is on the New Red, an undoubted supply of very pure water, enough for drinking purposes, might be obtained; that is to say, enough for the wants of from 45,000 to 50,000 persons.

The purpose of this paper is to raise the question among scientific men as to the probability or improbability of so much water being obtained by boring within the city or its environs.

Of course, all subterranean water must have, at some time or other, percolated through the cracks and rents of the surface rocks, and the quantity of water must largely depend upon the surface configuration of the locality. A flat surface is more likely to retain the water than rising ground. Remembering that Exeter is on a tongue of land, and, except towards the east, is surrounded by valleys, it may be fairly assumed that more than the average quantity of rainwater finds its way to the sea. An authority on these matters stated at a recent meeting of the British Association that probably one-third of the rainfall entered the rocks. But I question very much if such a proportion will be found in the rocks of Exeter. Necessarily, any computation as to the proportion of the 30 inches of annual rainfall that enters its rocks must be hypothetical. It must also be remembered that the inclination of the beds from or towards the city will be an important factor, as water usually works its way along the plane of the beds. I have known instances of well-water being abundant on one side of a valley, and none to be met with at similar depths on the other side. But with this I will deal more fully hereafter.

Reference to a geological map will show that Exeter is in part on carboniferous shales, in part on the Trap, and also on the New Red. During the formation of the shales, and most likely towards the close of the carboniferous period, the whole of this neighbourhood—and more or less, from Dartmouth to the Land's End—was greatly exposed to earthquakes and volcanic eruptions. De la Beche says: 'The whole of the Slates and Sandstones are intermingled with the Trappean in a way to show that there must have been considerable igneous action, during which ashes and vesicular lavas showing little pressure were ejected contemporaneously with the deposit of the slates and the sandstones.' This authority here more particularly refers to the district between Dartmoor and the Land's End; but it appears that a similar volcanic action characterised the termination of the shale period in this locality. Between Exeter and Dartmoor are several volcanic vents, and everywhere in this locality the shale is contorted and torn in almost every conceivable manner. I might also observe that in an important section of the New Red in the Heavitree Quarry, the cleavage joints are for the most part so filled with carbonate of lime as to render it impossible for water to find its way through them. Hence the action of springs in that quarry.

Exeter, geologically, may be divided into several areas:—

1st. From the South Western Railway Station to the bottom of Exe Lane, along what was formerly the Brook, then around the Princess Road to Fore Street Hill, and thence by Fore Street Hill to the West of England Insurance Office, an area will be described which has a stratum of clay from 2ft. to 4ft. thick, of a yellowish colour and very tough, and beneath the carboniferous shale, commonly called shillet, to a considerable depth. My friend Mr. Parfitt, of the Devon and Exeter Institution, has kindly supplied me with the notes of a boring at St. Ann's Well Brewery, commenced in March of last year. This well will be found situated about midway between Queen Street Station and Exe Lane, and before the filling up of the valley for railway purposes was on the 'nap' of the hill descending to the valley. The boring commenced in the shillet and only reached water at a depth of 305 feet, and then only in quantity not much in excess of the requirements of the Brewery. Mr. Parfitt has also furnished me with the notes of a boring of a well for the City Brewery in 1849. At a depth of 15 feet the boring was through water gravel, then for 85 feet through the shillet, for 54 feet more through alternate layers of trap and red shillet, then for 90 feet through blue shale, for 3ft. through water sand, and for 23 feet more through blue shale, making a total of 270 feet. This great depth was necessary in order to obtain water, and although in a valley, you will perceive, is not much less than the number of feet necessary to be bored for the St. Ann's Well Brewery.

In digging wells in this rock the depths at which water is obtained differ very extraordinarily. A well has a fairly good supply at a depth of nine or ten feet in one place, while others not 20 yards off have not had water at less than 50 or 60 feet, and in the cases of the St. Ann's and City Brewery Wells an approximate depth of 300 feet had to be reached. This probably results from the presence of numerous faults, or slides of large masses of rock, from various causes, but mainly volcanic. A very good section of this rock may be seen in the Princess Road, close to Head Weir.

2nd. If another line be drawn from Gandy Street up High Street, along Longbrook Street, then descending to the bottom of the street and following the line of the ancient brook to the South Western Railway station, it will be found to encircle the igneous rock on which the Castle of Exeter stands. The least exposed portion of this rock is very compact and ponderous, and when a portion of the base of the hill was cut away for the South Western station it was thought that the stone was sufficiently hard for the bridge which spans the railway near the prison; but after a few years of exposure the stone softened and gradually crumbled away. It has a granulated, or small grainy, and purple ground, sprinkled with minute shining points. It has numerous fissures crossing in all directions, or filled with white hard veins of calcareous spar. After long exposure this stone degenerates into a red clay, and this clay composes the surface of the Castle Hill, from whence no doubt this eminence derives the name of 'Rougemont.' This, it must be remembered, was a volcanic rock, and was probably thrust up at the close of the carboniferous period, which will probably account for the very broken and disturbed condition of the surrounding shillet.

3rd. From St. Stephen's Bow to St. John's Hospital, including Bedford Circus, the stratum is of sand and gravel; this is followed by clay, mixed with small masses of the disintegrated rock of the Castle, and the masses becoming larger and more compact soon form a rock of the same kind. The wells in this area are from 20 feet to 30 feet deep, and give excellent water. The well water of this locality is far preferable to that of the shale; but immediately beyond the Circus, or Southernhay, we find water certainly unfit for domestic use. In a well behind my own house, in the middle of Southernhay, the water was declared by the city analyst some twelve months ago to be unfit for such use. I have been unable to trace the cause of the presence of so much ammonia in this water.

4th. Above St. John's Hospital and Longbrook Street, the second stratum is a fine red sand about 60 feet thick. Under this, in some places, is a bed of soft marl from 4 feet to 6 feet deep, and then again the red sand. The sand extends all over St. Sidwell's to the Black Boy Turnpike Gate. The soil of the adjacent fields has been for a century and upwards used by the brickmakers. But in this area of the New Red there is less water than might be supposed. At Lion's Holt there has been a very fine spring from time immemorial, and although it comes through the thin bed of the Trias at that place, I have been long in doubt whether it really came from the New Red or from the shale underneath. At Polsloe Road the wells are from 20 feet to 30 feet deep, and yield an average supply of water, but, as I am told, not much in excess of the wants of the owners thereof. Mr. Hitt, of Heavitree, told me a few days ago that there was a well 100 feet deep in the New Red at the corner of the road leading from Magdalen Road to the Barnfield, and, although at so great a depth, there was scarcely any water.

5th. But to be more comprehensive it may be briefly stated that a line drawn from Taylor and Boxley's iron foundry in Commercial Road to Lion's Holt, thence to the Blackboy Turnpike Gate, will describe the boundary line between the shillet and the Trias. In other words, the half of the city on the north and west sides will be altogether on the shillet, and that on the south and eastern portion will be on the New Red; but, necessarily from its conjunction with the shale, there will be no considerable depth of New Red except at some distance from the city.

My conclusions are, first, that in and around Exeter natural underground basins for the collection of water are not likely to be met with, and that the improbability is rendered greater by the presence in the very heart of the city of an extinct volcano, which has considerably upheaved the beds and broken them in almost every conceivable variety of manner. 2nd, that the depth at which water can be obtained in the shale, indeed the finding of water at all in any large quantity, is so uncertain as scarcely to justify the expenditure necessary for an experiment. 3rd, that the New Red on the south-eastern side of the city being so thin, and the surface configuration of this part of the city unfavourable to the collection of a large quantity of water, I am unable to believe that water in anything like a large supply can possibly be obtained at a nearer point than the lower part of Heavitree, about one mile and a half from the centre of the city.

THOMAS ANDREW, F.G.S.

Mr. MARTIN, C.E., said that, as a citizen, he desired to say that they ought to feel greatly obliged to Mr. Andrew for the light he had thrown on the subject. They had been reminded from time to time that there was a report by a distinguished hydraulic engineer which recommended them to search for water immediately under their feet. That report had not been published. He thought it a pity that they should be so often reminded of this without their knowing its tendency. He quite endorsed the remarks as to the supply of water at Lion's Holt. Mr. Andrew did not say in direct terms, but left them to infer, that the water issued from the carboniferous mass and simply oozed out through the new red in the lower part of the valley. He had under consideration the boring of a deep well at Teignmouth, and on making inquiries as to the boring of wells, he was surprised at the result. Two cases were mentioned by Mr. Andrew. At Exminster the boring was made in the new red sandstone, and then they had to go to a great depth into the carboniferous shale. He mentioned the depths of the wells in several places to show to what extent they had to bore, viz., at Exminster, 473 feet; at Crediton, 246 feet; at Silverton, 257 feet; Topsham, 220 feet. If they had to go to such a great depth they would have to pump it up at some cost. They were told from time to time that there was abundance of water at Lion's Holt to supply the city. People imagined that because there was water upon the surface there was an inexhaustible supply underneath. Some time ago he was asked to go to Marypole Head and report on a supply there. A report from a gentleman who signed himself 'C.E.,' stated that there was abundance of water on the top of Marypole Head. He went there, but declined to report, as there was not enough to report on. There was just enough water to flow through an inch pipe.

Mr. Parfitt said they must bear in mind that from the river Exe, extending about 1¾ mile in an easterly direction, was the collecting ground of the water, broken up by geological 'faults,' and he was certain that it would be impossible to collect from this land sufficient water for Exeter. Just below Polsloe Farm there was a very thin layer of the new red sandstone over the carboniferous; it lay along the whole of the valley cut by the South-Western Railway. Two gunshots beyond that, there was a cutting, where the brook had cut its way down to 30 feet or 40 feet, and this showed that it was 'faulted' against the carboniferous. It held the water in this particular place for what was called St. Ann's Well. There was no other place where there was anything like a supply for a large city. At Heavitree Brewery the well was 375 feet deep, and as it did not yield a sufficient supply it was intended to sink it to a depth of 400 feet, to ascertain if it would yield more water. In his opinion, the ground all round about Exeter, within the collecting area, with a diameter of about two miles, was so 'faulted' that it was not likely that water would be obtained from it in sufficient quantity for the city of Exeter.

Mr. Bodley had been told that in Exeter they had an imaginary supply of water immediately beneath their feet; but having been engaged in connection with the large pumping wells in the neighbourhood, he could refute that piece of imagination. The local papermakers, in an endeavour to compete with the Kent papermakers, tried three wells at Exeter, but the water was unsuitable for papermaking. At Huxham and Heavitree wells were bored with the same result. At the Lunatic Asylum at Exminster there were wells 114 feet and 120 feet deep.

Mr. Parfitt: 375 at Exminster.

Mr. Bodley maintained that his figures were correct. He had been unable to find such a bore as 375 feet at Exminster. In that neighbourhood the wells did not supply anything like the quantity of water they were supposed to do. As to the St. Thomas water-supply, the well first went through the top soil, then through 9 feet or 10 feet of gravel to the shillet. No water was obtained from the gravel to the shillet; all that was obtained was from the gravel, a quantity so small as to be unappreciable. It was foolish of the citizens to attempt to sink a well—unless, indeed, they went to an enormous depth. There was no percolation through the shillet from which they could get the water. At the brickyards a sufficient supply of water could not be obtained from the wells to saturate the clay for making into bricks.

Dr. Carpenter said that the water he had had since he came to Exeter had been very good so far as its appearance went, and he should be satisfied with it if the source were not polluted. He understood that this was obtained from their natural source, the collecting ground which nature had provided for the city of Exeter. The citizens of Exeter would not have far to go for a water supply, for nature had provided them with a collecting ground in their neighbourhood, the overflow of which went into the river. It was very wrong of the authorities to allow such rivers to be defiled, as they ran from their pure source. It was morally and physically wrong on the part of any local authority to pour into those rivers the sewage of their towns in the unpurified state in which it was poured into their rivers, and as he knew that it was poured into the river at Exeter. They should compel the authorities in the higher part of the district, as well as those nearer Exeter, to refrain from polluting the river, and then there would be an abundant supply of good water. Providence had some other object in providing rivers than—as a gentleman once said he regarded them—for the supply of canals or to build our towns upon. The rivers never failed, and were provided for our supply of water; and the lake districts were intended to provide for the great centres of population that which they want, pure water. If the law were carried out properly, there would be no deficiency in the water supply for the city of Exeter.

Mr. Rawlinson said this was essentially a local question. Whether water could be got in sufficient quantity from wells could only be tested by the fact of its being got. It was no use to speculate, geologically or meteorologically; and after the evidence they had heard it was not very encouraging for them at Exeter to go to a large expenditure in the endeavour to get a water supply from that source. Liverpool and Manchester, once supplied from wells, had had to give them up and go beyond. Wolverhampton had had to go outside and get water *plus* the wells. Birmingham had also to supplement its wells. New York had had to do the same. Many persons, and perhaps there were some of them here, were so stubborn that the Archangel Gabriel would not be able to convince them to the contrary if they had once got it into their crotchetty heads, that they had only to sink a well and get water—leading the Town Councils into expenditure because they would listen to neither rhyme nor reason. They declared that water could be got, and they induced Town Councils to expend money because they thought that the water ought to be got. It was important that Exeter should not be led such a dance. Others said, 'Go deep enough, and you are sure to get water.' Those gentlemen showed that they knew nothing of the crust of the earth. In Yorkshire there were mines of from 1,000ft. to 2,000ft. in depth, and he did not know any mine exceeding 1,000ft. deep which did not go below the water-bearing strata, so that they had to send down water to water the subterranean roads. Bath stood upon the oolites, and its hot water was got from the stratification.

Buxton and Matlock stood on the limestone. All limestones were fissured. Rain was the purest water. It filtered into the cracks or fissures, combined with the lime and took away the bicarbonate, until ultimately we had the surface water, after descending in a syphon to perhaps 5,000ft. or 6,000ft., coming up to the surface. There was nothing magical about it. If they attempted at Exeter to get water from the new red sandstone, they would fail; as, judging from the geological 'dip,' as now exhibited in the diagrams, it all went away, although he could not say where it went to. But there must be places, not very far distant, where they could get a good supply, if the river was not satisfactory. He would recommend the Town Council, before expending any money on well-sinking, to obtain the Sixth Report of the Rivers Pollution Commission, which contained more information on wells, well-boring, and analyses, than any he knew; and if their member, Mr. Stafford Northcote, would get them a copy of that report, they might study it with great advantage.

Mr. Symons wished to scold the Devonshire people. The Devonshire Association for the Advancement of Science, of which all England was proud, had a branch devoted to Meteorology; but it seemed that their efforts in the direction of Meteorology were going to collapse, and that was not creditable to Devonshire. It was one of the illustrations of the contact of science and practical life. In reference to the subject of the paper, Mr. Rawlinson had epitomised for them the experience of other places. Some people liked to buy their experience. He advised Exeter not to do so, in regard to sinking wells for water. No matter how much sewage might be purified, he did not like the idea of drinking the water after it came from the sewage farm. He should infinitely prefer going to those glorious moors and taking the water, which was perfectly pure, only tinged with a little peat, which was absolutely harmless. Whatever engineer might be employed, he would be to a great extent blindfold if he went to Dartmoor without ascertaining the rainfall, while the expenditure of a trumpery sum, perhaps £20, would supply the requisite meteorological data, and might save the expenditure of thousands of pounds.

The Rev. Treasurer Hawker remarked that nobody would attempt to keep a rain-gauge on Dartmoor unless he wished to kill himself or his friends, as, for some months the centre of Dartmoor was inaccessible. The only means of obtaining meteorological information would be by sending out relays of convicts.

Mr. Symons could not understand why Dartmoor should be worse than Helvellyn, Skiddaw, Scawfell, Birkside, and other mountains in Cumberland, on all of which records were kept.

Mr. Bodley advised Mr. Symons to go across Dartmoor to Princetown and Tavistock.

Mr. Symons had spent a week at Princetown, and had placed more rain-gauges on Dartmoor than all the Devonshire gentlemen put together. He wished they would give him their co-operation.

Mr. Grantham had just completed some well-borings in the tertiary, in the endeavour to get down to the greensand, under the supposition that they would get a larger and better quantity of water than from the chalk. In boring they found that they completely tubbed out the vein which contained the water in the chalk. In Devonshire it would be almost impossible to calculate where they would get water from subterranean wells; and with the geological formation represented, to be supplied with subterranean wells was not to be expected. The Dartmoor supply, if it could be got, would be a very simple thing.

Mr. Parfitt would endeavour, as one of the members of the Devonshire Association and connected with its meteorological branch, to rub out Mr. Symons's stigma of want of interest in meteorology. The Meteorological Society had undertaken to take all the rain-gauges into their keeping. It was not considered advisable that the Meteorological Society and the Devonshire Association should be working on the same ground; and, although they were very reluctant to do so, the Devonshire Association gave up the maintenance of the rain-gauges. He hoped that Mr. Symons would lift the veil of mystery which seemed to hang over the proceedings of the Meteorological Society in connection with this subject. As to the Dartmoor supply, on Dartmoor in the summer he had seen the streams dry, except in the pools, and at Totnes he had taken samples of water like Dublin stout.

Mr. Rawlinson said this showed how dangerous it was to speak without book. If anyone said it was useless to attempt to get water because he saw none when the streams were dry in the summer, it showed that he knew nothing about it. It was for the engineer to step in and provide reservoirs in which to store the water, except where they had rivers like the Lea and Thames, which supplied the 155,000,000 gallons a day pumped into London.

Mr. Symons said that he was the President of the Meteorological Society, to which these stations were proposed to be entrusted, and he thought it a very singular thing that the Devonshire Association should wish to drop their supervision and quietly hand it over to them. He explained that the Meteorological Society did not desire to monopolise the work, but wished that the Devonshire Association should render its energetic co-operation.

Mr. C. Fox (Wellington) suggested that if Dartmoor could supply Plymouth, certainly it should supply Exeter. He also recommended the perforation of Haldon.

The President, as a geologist, had no hesitation in saying that the author of the paper was abundantly justified in the advice which he had given. Strata like that at Exeter, could not have a water-bearing power. If the Exe were purified as nature made it, there would be no difficulty in the supply of water to the city.

The Mayor of Exeter, in moving a vote of thanks to Mr. Andrew, said that it was fortunate for the citizens that the discussion had been raised. After the opinions expressed by Mr. Rawlinson and Mr. Symons, instead of wasting time on impracticable schemes, Exonians should now set to work and call upon the towns on the banks of the Exe to stop the flow of sewage into the river.

Mr. Grantham said that Mr. Andrew had contributed a highly valuable paper for the inhabitants of Exeter, and the evidence which had come out had proved what the author had advanced.

Mr. Andrew, in acknowledging the vote of thanks, remarked on the suggestion that Haldon should be perforated, that he did not believe it would be advantageous, judging from the surface configuration.

The President observed that there was a supply of water on the west side of Dartmoor, and he had very little doubt that there was a similar supply on the east side, which he should recommend to be tried. The President said that since the discussion of Mr. Andrew's paper he had received a letter which Mr. Symons would read.—The communication was from Dr. Bankart, who wrote that as he had only heard part of the paper read he was unable to say then what he wished to be said. The fact was that though, before the purchase of the Water Works by the city, a great outcry was made against the impurity of the water as now supplied, yet, since the purchase, the question of impurity appeared to be ignored. The quantity had been improved, and he believed the Council were anxious to do their best for the town, but they were afraid to meet the popular outcry against spending money. As the chief question with them was one of rates, they required the support of a powerful body like the Sanitary Institute to enable them to do their duty. In spite of analysis, there was the well-known fact that at one spot there was daily poured into the Exeter water supply the excreta of 10,000 people, with their diseases, not to mention the sewage of the smaller towns and villages, and the drainage of land along the twenty miles of river. The Institute would confer a lasting benefit upon the citizens if it would record its opinion that the city authorities were leaving undone a very important duty so long as they failed to give the citizens a constant supply, the quality of which should be above suspicion.

On the Sanitary Condition of Wells in Exeter and Neighbourhood.

This is not the first time that the wells situated in or near Exeter have formed a theme for writing or discussion. In Dr. Shapter's 'Climate of the South of Devon' is an interesting account of many of the natural springs and wells of the neighbourhood, and in the 'History of the Cholera in Exeter,' by the same author, the closing of certain wells of the city, which at that time were considered impure, is mentioned. In older works, too, devoted to the doings of ancient Exeter, frequent allusions are made to the then important subject—the maintenance in proper condition of the wells of the city.

The aim of this short paper, however, is not so much to deal with their past history as to show the connection existing, or which is frequently established, between health and disease by means of wells (often nothing but mere pits for the reception of drainage water and contaminations of the worst kind), to show that it is often best—putting a new construction on an old adage—'to leave the well alone.'

To paraphrase the words of a distinguished chemist, what people had to find out for themselves by long and perhaps hazardous experience it is the lot of the analyst in these days to do for them, and in this capacity I have had the opportunity within the last few years of examining many wells, both in the city and out of it. The analyses now placed before you are selected from the worst and the best specimens of water analysed.

The first on the list is from a farm not far from Alphington. The water had been used freely for drinking, for household purposes, for the cattle, for washing butter, &c. Ill-health prevailed. The means of getting a good supply was suggested—viz. to sink a well in the sandstone far away from the present source of contamination (the farmyard). This advice was acted on, good water was obtained, and with it improved health to the inmates of the farm.

It will be observed that for the estimation of organic matter the ammonia process has been adopted. It has many detractors, but it still holds its own, and for sanitary purposes it is very convenient. It has its faults undoubtedly, but where is the process that is perfection?

To pronounce on a water, however, merely from the determination of one constituent, would be folly. Many of the most impure waters figuring in the above table may thus be made to pass muster. Whatever method is used, each figure in the analysis must have its signification, and it is only by a careful study of the whole that the analyst is led to a correct conclusion.

In example No. 1 the free ammonia vastly preponderates over the organic, while the chlorine is also high; the water evidently belongs to the ureal class, and fresh sewage is constantly percolating to the well.

The next examples (Nos. 2, 3) are from the village of Alphington, where it appears the drinking water is far from good. The analyses are from a couple of wells situated very near each other. They resemble each other closely, both showing a large proportion of nitrogen as nitrates and nitrites.*

Of the water of St. Thomas I have, unfortunately, no examples.

At Topsham, on the other side of the Exe, we find that the wells near the river are extremely foul, but in higher situations there is good water. Cases of fever are, I believe, not unfrequent in the lower regions, brought on without doubt by drinking the river impurities

* Since writing the above, I have been informed that these wells are not far from the churchyard.

which have filtered through to the wells. The analysis No. 4 is that of a horrible specimen; the water contained so much salt as to taste of it.

Coming nearer to Exeter on the Topsham Road, about half a mile from the city, there is Parker's well, formerly in estimation as a holy well. Whether the small proportion of iron it contains really did act beneficially on the pilgrim's sight, or whether it was merely the invigorating walk and the coolness of the water, is open to question. However, analysis shows it in a favourable light. The water is clear as crystal, and contains but few impurities past or present.

Just below this well, and close to the river, is one which is rather notorious—a well, from which it was proposed at one time to draw a supply for the city, and which has been stated to be artesian. This assertion has evidently been founded on an observation by Sir H. De la Beche (see 'Geol. Report on Devon and Cornwall,' page 116), but the frequent disturbances of strata which have taken place in the neighbourhood of Exeter entirely preclude the idea of an arrangement favourable to the sinking of an artesian well. The boring is stated to be less than 100 feet deep, and the supply constant; but that it is derived from a distant outcrop and filters through the sandstone is impossible. This statement is confirmed by the analysis, for water that had filtered through such a depth of sandstone could not contain so large an amount of organic matter. It would have been almost entirely oxidised. Its bright and sparkling appearance is deceptive, for looked at through a deep stratum it is turbid and has a tint of yellow. Much of it, doubtless, is river water that has found its way through natural crevices in the rock, and the organic matter shown here as organic ammonia is the remains of Exeter sewage. This is not the only analysis that has been made of this water. One eminent authority gives it as his opinion that 'it is more suited for irrigation than for drinking.'

But a short distance from Parker's well we come to examples which show how the abominable system of dealing with sewage by water ruins wells, for in St. Leonard's are wells which have been spoiled in this way. Both the organic ammonia and the chlorine in Nos. 8 and 9 show that the water is filthy, and from its use fever has resulted.

No. 10 is a specimen of fairly good water from the same district, and not 200 yards from the contaminated wells.

We now go towards Pennsylvania. At Edgerton Park and at the terrace above, good water is found, but at a villa below it is unfit for use, the drainage being defective. The Lion's Holt supply has long been known as superior. The well of St. Anne was formerly *the* supply of Exeter. In the history of the cholera in Exeter is a note stating that 'as early as 1221 this water was brought into the city from its present sources in the upper part of the parish of St. Sidwell, and delivered by a conduit erected in the centre of the High Street below the Quatrefois.' In 1346 it is mentioned as 'conveyed into St. Peter's yard,' 'whence,' Dr. Oliver informs us, 'it branched into three channels, one for the use of the members of the cathedral, another for the city, and a third for St. Nicholas Priory.' During the cutting of the

London and South Western Railway the springs were seriously damaged, but even now the water brought down to the city and the cathedral is supplied as in olden time. Analysis No. 14 proves it to be a good, cool, pleasant water, showing but little organic matter.

Rather above this well, in Well Lane, just under York Buildings and close by the St. Sidwell's Churchyard, is a public well, which in 'days gone by' was doubtless as pure as the fount of St. Anne. It has, however, lost its reputation and is now closed. Analysis No. 16 shows it to be teeming with impurities. As I have noticed the boys of the school opposite filling their hands or their caps with water from the pump and drinking therefrom, I have been unable to resist the conclusion that their drink might very probably consist of a solution of ancient parishioners, and that possibly they would pay for their draught by a serious attack of illness.

In the high ground of Polsloe Road the water, as may be expected, is naturally good, but the devices of man tend to contaminate it. In analysis No. 18, traces of recent contamination having been discovered, the well was examined and a dead cat was pulled out.

At Heavitree Bridge, very close to the brook flowing by the little village of East Worford, is a spring which Jenkins, in his 'Memories of Exeter,' tells us, 'from an iron ladle formerly fastened to a chain to the wall for the benefit of passengers drinking, obtained the name of Iron Dish.' Analysis No. 19 shows the water is still good. The brook is now nothing better than an open sewer, giving off its foul emanations and poisoning the air of one of the most beautiful walks in the neighbourhood, viz. the Worford Fields. Of city wells but little of good can be said; the soil there is saturated with impurities which find their way into the wells. 'Beautiful water and preferred to any other' is said of many a specimen which when analysed proves to be a mass of corruption, and on inquiry it has generally been found that, if there has not been fever, the people using it are what is called 'ailing.' Not one of the old public wells within the city yet examined yields good water. Formerly they abounded; every street had its pump. The Palace Street pump was one of the last to be closed. From these examples, then, it will be evident that nature supplies the provinces with good water, for on every side of the city, be it from the red sandstone or from carboniferous strata, favourable analyses are obtained. It is only when by defective drainage the ground is given too much to do, when from the excess of impurities with which it is loaded it is unable to perform the office of purification appointed to it, that we find unwholesome water, and this cannot be remedied until the system of *dealing with sewage by means of water* is finished with. Then, and not till then, may we who live in cities hope to drink water rendered healthful by Nature's own filtration.

Frank P. Perkins,
Public Analyst for the City of Exeter.

Composition of Various Waters.

No.	Description	Total solid matter	Free Ammonia	Organic Ammonia	Nitrogen as Nitrates and Nitrites	Organic Nitrogen	Inorganic Nitrogen	Total combined Nitrogen	Total Chlorine	Chlorine calculated as Common Salt
1	Farm near Alphington	—	·405	·033	·366	·0271	·696	·7231	9·3	15·3
2	Alphington . . .	45	·0025	·0083	1·09	·0068	1·092	1·0989	4.0	6·59
3	,, . . .	47	·001	·008	1·09	·0065	1·0908	1·0973	5·5	9·34
4	Topsham . . .	50	·0026	·0044	·443	·0036	·4451	·3667	5·7	9·39
5	,, . . .	186	·0106	·042	2·08	·0345	2·0887	2·1233	40·5	66·6
6	Parker's Well . .	45	·0036	·0022	·362	·0018	·3649	·3667	4·8	7·9
7	Trew's Weir . .	78	·0106	·0174	1·01	·0143	1·0187	1·033	6·5	1·07
8	St. Leonard's . .	82	·008	·004	·792	·0033	·7986	·8018	8·0	13·1
9	,, . .	78	·0106	·0187	·757	·0154	·7657	·7811	15·0	24·7
10	,, . .	55	·0053	·0047	·549	·0038	·5533	·5572	3·2	5·27
11	Pennsylvania . .	—	—	·007	·256	·0057	·256	·2617	3·9	6·42
12	,, . .	—	·001	·006	·290	·0049	·2908	·2957	2·6	4·28
13	,, . .	128	·0665	·0135	·44	·0111	·4947	·5058	42·0	69·2
14	Lion's Holt . . .	—	·004	·0074	·236	·0061	·2393	·2454	5·7	9·39
15	,, Cathedral School	—	·0013	·006	·445	·0049	·446	·4509	5·6	9·22
16	Well Lane Public Pump	—	·078	·0225	·313	·0191	·3711	·3902	9·0	14·83
17	Polstoe Road . .	—	·0015	·0065	·321	·0053	·3222	·3275	4·6	7·6
18	,, . . .	45	·0532	·010	·548	·0082	·5918	·600	2·4	3·95
19	Heavitree . . .	42	·001	·0042	·579	·0034	·5572	·5606	3·0	4·9
20	City Wells, High St. .	136	·0053	·0125	·900	·0103	·9043	·9176	12·3	20·1
21	,, Fore St. .	90	·260	·0266	·5476	·0219	·7616	·7835	17·2	28·3
22	,, Palace St. (P. P.)	—	·006	·0118	428	·0097	·4329	·4426	16·5	27·22
23	,, Frog St. .	43	·008	·005	440	·0041	·4466	·4507	5·7	9·39
24	,, Fuernhay St.	20	·0027	·0103	214	·0084	·2162	·2246	1·2	1·93

Mr. Parfitt considered this paper a most important one, and, taken in conjunction with that of Mr. Andrews, it should have considerable weight in the Town Council in the discussion of any proposition brought before them for the supply of water.

Mr. Grantham said that when he heard that the wells were 24 feet or 25 feet in depth, he suspected that some of them must be in a dangerous state. With so slight a depth it was almost impossible to avoid pollution, which could only be done in wells at a great depth. He was not at all surprised to find the results indicated by Mr. Perkins after hearing Mr. Andrews' paper. As to the well particularly near a churchyard, common sense would tell them that its pollution could be fairly traced to its source. No one in his senses would sink a well near a churchyard or a slaughter-house, or in the precincts of a town where pollution could come to it.

Mr. Symons said it was not everybody who knew that churchyard water was bad. At Cromer a few years since he was recommended to try the water at a stationer's shop, as he and his wife were rendered ill by the ordinary supply. He got some out of curiosity, and found it bright and sparkling; but the stationer's shop was next but one to the churchyard, and the sparkle was the lure of death.

The President concurred, and said that the London pumps in Bishopsgate and Moorgate, to which the City bankers and merchants used to send for water for their luncheon, had been removed since the demonstration that churchyard water is so bad. It was very bright and refreshing, although so deleterious, for the salts that it contained gave it the bright and sparkling appearance.

Some Deficiencies in our Knowledge Respecting Health Resorts.

THE remarks which I have to offer upon the present occasion differ materially in their character from those which are assumed to usually form the basis of those submitted to scientific bodies.

As a rule, an author reads a paper in order to bring before his audience, and perhaps still more before that far larger audience which he addresses through the press, something which he believes to be new, something which he hopes will make the world wiser and better than it would be without it.

I am aware that there are persons who read papers with the sole desire to see their names in print, and others who do so to puff the commodities in which they deal—but they are beneath notice.

The usual object of a paper is, then, to afford information. But mine is to obtain it, and although perhaps I shall give a little in the mere explanation of what I want, still I hope that the balance will eventually be largely in my favour, and that is why the title of this paper does not promise any information at all.

It has lately been said, and I think with truth, that whereas in past years the Autumn holiday was a *luxury*, it has, through increasing exhaustion due to modern high pressure, become a *necessity*.

Assuming that to be true, it is obviously of increasing importance that the localities to which we temporarily migrate should be as healthy as they can be made.

And here it may be as well to remark that the visitors are better judges of what is healthy than the residents. Those who spend the whole twelvemonth on a bracing mountain slope cannot realise that it matters whether the bedroom windows open at the top or not; and, as sleeping in a close room does not affect them, they set any remonstrance down as a whim of their visitors, forgetting that it is the constant breathing of a pure atmosphere during the day and all through the year which enables them to sleep in a used-up atmosphere with impunity—and equally forgetting that it is largely for the sake of pure air that their visitors come, that where they get most pure air they will derive most benefit, and will therefore be most likely to come again

I have quoted only one feature—windows; but need hardly say that identical reasoning applies to cleanliness in every respect—to purity of water, to the quality and cooking of food, and, indeed, to all the ministrations of life.

This digression has taken me far away from the subject I wish to bring before you. I must return abruptly, and try to keep closer to it.

I am far from denying that, in spite of the very unsanitary—and, to our notions, offensive—arrangements existing at many places on the Continent, it is often better for persons to go to a continental health resort than to stop in the United Kingdom, because the change of air, scene, habit, and language is much greater. Yet, I believe, it would be far better to bestow more attention on our own health resorts than we do.

And I think that few persons have the least idea of the number of the mineral springs and sea-bathing places in the British Isles. Many years ago, when investigating the rainfall at some of our health resorts, I compiled a list of those that I then knew of. The total number was rather more than three hundred, but having learnt of several since, and made the list far more extensive than any that I have ever seen, I have inserted it in this paper in the hope that it may prove an acceptable contribution to our Transactions.

At the outset, however, it is necessary to consider what constitutes a health resort. The definition is by no means easy. Are all places where mineral springs exist to be called health resorts? If so, scores of places where there is not the slightest accommodation for visitors, and of which 999 persons out of every 1,000 have never heard, must be included. Are all seaside towns and villages to be considered health resorts? Some of them are, I fear, far from being either salubrious or adapted for receiving visitors. Are we to exclude all places which have neither mineral springs nor sea bathing? If so, we must exclude some localities which are extremely well adapted for the restoration of persons suffering the penalty of 'life at high pressure.'

I think that in this matter, as in most others, no hard and fast line is possible, and the course which I have adopted is, therefore, an intermediate one.

There are yet a few other prefatory remarks. The places are arranged alphabetically. The prefix M denotes that a mineral spring exists there, except when the **M** is substituted for M, in which case I have reason to believe that, as at Bagnigge Wells, Hartlepool, and other places, the spring has been lost. The prefix S denotes a seaside resort, and in most cases one with bathing accommodation.

I shall be much obliged to anyone who will enable me to correct this table, by sending me statements of facts *within his own personal knowledge*. I do not wish for second-hand information.

S	Aberayron	Cardigan
S	Aberdeen	Aberdeen
S	Aberdour	Fife
S	Aberdovey	Merioneth
S	Abergele	Denbigh
S	Aberystwith	Cardigan
M	Acton	Middlesex
M	Admaston	Salop
M	Airthrie	Stirling
S	Aldborough	Suffolk
S	Alderney	Alderney
M	Aldfield	York, W.R.
M	Alford	Lincoln
M	Alford	Somerset
M S	Arbroath	Forfar
S	Ardrossan	Ayr
M	Ashby-de-la-Zouch	Leicester
M	Ashtead	Surrey
M	Askern	York
M	Astrop	Northampton
M	Axwell	Durham
M	Bagnigge Wells	Middlesex
M	Baillieborough	Cavan
M	Ballycastle	Antrim

M	Ballynahinch . .	Down
M	Ballyspellan . .	Kilkenny
S	Banff	Banff
S	Bangor	Carnarvon
S	Barmouth . . .	Merioneth
M	Barnet	Herts
M	Bath	Somerset
S	Beaumaris . . .	Anglesea
M	Belturbet . . .	Cavan
	Ben Rhydding, *see Ilkley*	
M	Beulah	Surrey
S	Bideford	Devon
M	Bilton	York, W.R.
M	Bircham	Berwick
S	Blackpool . . .	Lancaster
M	Block	Dumfries
S	Bognor	Sussex
M	Bonnington . . .	Edinburgh
S	Borth	Cardigan
M	Boscombe . . .	Hants
M	Bourne Moor . .	Durham
M S	Bournemouth . .	Hants
S	Bray	Wicklow
M	Brentwood . . .	Essex
	Bridge of Allan, *see Airthrie.*	
	Bridge of Earn, *see Pitcaithly.*	
M S	Bridlington . . .	York, E. R.
M S	Brighton	Sussex
M	Bristol	Gloucester
S	Broadstairs . . .	Kent
M	Bromley	Kent
M	Brough	Westmoreland
M	Broughton . . .	York, W. R.
S	Broughty Ferry .	Forfar
M S	Buckie	Banff
S	Budleigh Salterton	Devon
M	Buglawton . . .	Chester
M	Builth	Brecknock
S	Bundoran . . .	Donegal
S	Burghead . . .	Elgin
S	Burntisland . . .	Fife
M	Butterby	Durham
M	Buxton	Derby
M	Candren	Renfrew
M S	Carrickfergus . .	Antrim
S	Cartmel	Lancaster
M	Castle Comer . .	Kilkenny
M	Castle Connel . .	Limerick
M	Chapelizod . . .	Dublin
M	Cheltenham . . .	Gloucester
M	Cherry Rock . .	Gloucester
M	Chigwell Row . .	Essex
M	Chippenham . .	Wilts
S	Cleethorpes . . .	Lincoln
S	Clevedon	Somerset
M	Clifton	Gloucester
M	Clitheroe	Lancaster
M	Closeburn . . .	Dumfries
M	Clunie	Perth
M	Cobham	Surrey
M	Codsall	Stafford
M	Colchester . . .	Essex
M	Coldbath	Middlesex
S	Colwyn	Denbigh
	Cootehill, *see Drumgoon.*	
M	Corstorphine . .	Edinburgh
S	Cove	Cork
M	Crickle	York, W. R.
M	Croft	York, N. R.
S	Cromer	Norfolk
M	Cronebawn . . .	Wicklow
M	Culgask	Perth
M	Cumner	Berks
S	Cushendall . . .	Antrim
S	Cushendun	Antrim
S	Dawlish	Devon
M	Delamere . . .	Cheshire
M	Dinsdale Spa . .	Durham
M	Dog and Duck .	Surrey
M	Dorton	Bucks
S	Dover	Kent
S	Dovercourt . . .	Essex
M	Drigg	Cumberland
M	Droitwich . . .	Worcester
M	Drumgoon . . .	Cavan
M	Drumsna	Leitrim
	Dulwich, *see Streatham.*	
M	Dunblane . . .	Perth
M	Dungannon . . .	Tyrone
S	Dunmore	Waterford
M	Dunse Spa . . .	Berwick
S	Eastbourne . . .	Sussex
M	Epsom	Surrey
M	Eskdaleside . . .	York, N. R.
M	Ewell	Surrey
S	Exmouth . . .	Devon
S	Felixstowe . . .	Suffolk
M	Felstead	Essex
M S	Filey	York, E. R.
M	Fir Hill	Aberdeen
S	Fishguard . . .	Pembroke
S	Fleetwood . . .	Lancaster
M S	Folkestone . . .	Kent
M	Gainsborough . .	Lincoln
M	Gethlyonen . . .	Glamorgan
M	Gilcomston . . .	Aberdeen
M	Gilsland	Cumberland
M	Glastonbury . .	Somerset
S	Glenarm	Antrim
M	Glendy	Kincardine
M	Gloucester . . .	Gloucester
S	Gourock	Renfrew
M S	Grange	Lancaster
S	Guernsey. . . .	Guernsey
M	Guisborough . .	York, N. R.
M	Gunfreston . . .	Pembroke
M	Hail Weston . .	Hunts
M	Hampstead . . .	Middlesex
M	Hanley's Spa . .	Salop
M	Harlow Carr . .	York, W. R.
M	Harrogate . . .	York, W. R.
	Hartfell, *see Moffat.*	
M	Hartlepool . . .	Durham
S	Harwich	Essex
M S	Hastings	Sussex
S	Helensburgh . .	Dumbarton
S	Herne Bay . . .	Kent
M	Hockley	Essex
M	Holbeck	York, W. R.
M	Holt	Wilts
M	Holt	Leicester
M	Holywell Spa . .	Lancaster
M	Horley Green . .	York, W. R.
	Hotwells, *see Clifton.*	
M	Hovingham . . .	York, N. R.
M	Hoxton	Middlesex

S	Hunstanton . . .	Norfolk
M	Hyde	Gloucester
S	Hythe	Kent
S	Ilfracombe . . .	Devon
M	Ilkley	York, W. R.
M	Ilmington . . .	Gloucester
M	Innerleithen . .	Peebles
M S	Inverkeithing . .	Fife
M	Ipswich	Suffolk
M	Islington	Middlesex
S	Jersey.	Jersey
M	Johnston	Kilkenny
M	Joppa	Edinburgh
M	Kedlestone . . .	Derby
M	Kensington . . .	Middlesex
M	Kilburn	Middlesex
M	Kilburn	Dumfries
M S	Kilkee	Clare
M	Killymard . . .	Donegal
M	Kilroot	Antrim
M	Kincardine . . .	Kincardine
M	Kinghorn . . .	Fife
M	King's Cliffe . .	Northampton
M	Kinoulton . . .	Nottingham
M	Knaresborough .	York, W. R.
M	Knaresdale . . .	Northumberland
M	Krevenish . . .	Fermanagh
S	Largs	Ayr
M	Lathom	Lancashire
M	Leamington. . .	Warwick
S	Lehinch	Clare
M	Lees	Lancashire
M	Lewes	Sussex
	Lewisham, *see Streatham.*	
M	Lisdoonvarna . .	Clare
S	Littlehampton . .	Sussex
M	Llandegley . . .	Radnor
M	Llandeinislen . .	Carnarvon
M	Llandrindod . .	Radnor
S	Llandudno . . .	Carnarvon
M	Llangammarch .	Brecon
M	Llangybi	Carnarvon
S	Llanstephan . .	Carmarthen
M	Llanwrtydd . . .	Brecon
S	Lossiemouth . .	Elgin
M	Lough Lea . . .	Cavan
S	Lowestoft . . .	Suffolk
M S	Lucan	Dublin
S	Lyme Regis. . .	Dorset
S	Lynmouth . . .	Devon
S	Lynton	Devon
S	Lytham	Lancaster
M S	Mallow	Cork
M	Malton	York, N. R.
M	Malvern	Worcester
S	Margate	Kent
M	Markshall . . .	Essex
M	Matlock	Derby
M	Melksham . . .	Wiltshire
M	Middleton . . .	Durham
	Middleton, *see Stony Middleton.*	
M	Middleton . . .	Carmarthen
M	Middlewich . . .	Cheshire
S	Miltown Malbay .	Clare
S	Minehead . . .	Somerset
M	Minty	Gloucester
M	Moffat	Dumfries
S	Morecambe . . .	Lancashire

M	Muirtown . . .	Ross
S	Mumbles	Glamorgan
S	Nairn	Nairn
M	Nantwich . . .	Cheshire
S	New Brighton . .	Cheshire
S	Newcastle . . .	Down
M	Newent	Gloucester
M	Newnham Regis .	Warwick
M	Newtondale . . .	York, N. R.
M	Normanby . . .	York, E. R.
	Northaw, *see Barnet.*	
S	N. Berwick . . .	Haddington
M	Nottington . . .	Dorset
S	Oban	Argyll
M	Offerton	Durham
M	Orston	Nottingham
S	Paignton	Devon
M	Pannanich . . .	Aberdeen
S	Penmaenmawr. .	Carnarvon
S	Penzance. . . .	Cornwall
M S	Peterhead . . .	Aberdeen
M	Pitcaithly . . .	Perth
S	Portobello . . .	Edinburgh
S	Portrush	Antrim
S	Port Stewart . .	Londonderry
M	Purton	Wilts
M	Radipole	Dorset
S	Ramsgate . . .	Kent
S	Redcar	York
M	Rhydryonem . .	Merioneth
S	Rhyll	Flint
M	Road	Wilts
M	Romford	Essex
S	Rosstrevor . . .	Down
M S	Rothesay. . . .	Bute
S	St. Andrews .	Fife
M	St. Bernards . .	Edinburgh
M	St. Chad	Middlesex
S	St. Leonards . .	Sussex
M	St. Pancras . . .	Middlesex
	St. Philip, *see Yarrow.*	
S	Salcombe. . . .	Devon
S	Saltburn	York
S	Sandown. . . .	Hants
S	Sandgate. . . .	Kent
M	Sandrock. . . .	Hants
S	Sark	Sark
M S	Scarborough . .	York
S	Seaford	Sussex
S	Seaton.	Devon
S	Seaton Carew . .	Durham
M	Shadwell	Middlesex
S	Shanklin	Hants
M	Shap	Westmoreland
S	Sheerness . . .	Kent
M	Shirleywich. . .	Stafford
M	Shotley Bridge .	Durham
S	Sidmouth . . .	Devon
S	Silloth	Cumberland
M	Skipton	York, W. R.
M	Slaithwaite . . .	York, W. R.
M	Somersham . . .	Hunts
S	Southend. . . .	Essex
S	Southport . . .	Lancaster
S	Southwold . . .	Suffolk
M S	Spital	Northumberland
M	Springkell . . .	Dumfries
M	Starbeck	York, W. R.

M	Stoke	Surrey
S	Stonehaven	Kincardine
M	Stony Middleton	Derby
M	Stony Stratford	Bucks
M	Strathpeffer	Ross
M	Streatham	Surrey
M	Sunninghill	Berks
M	Sutton	Surrey
M	Sutton Coldfield	Warwick
S	Swanage	Dorset
M	Swanlinbar	Cavan
M S	Swansea	Glamorgan
	Sydenham, *see Streatham.*	
M	Taafe	Glamorgan
S	Teignmouth	Devon
M	Tenbury	Worcester
S	Tenby	Pembroke
M	Tewkesbury	Gloucester
M	Thetford	Norfolk
M	Thorlies Hope	Roxburgh
M	Thorp Arch	York
M	Tilbury	Essex
S	Torquay	Devon
S	Towyn	Merioneth
M S	Tralee	Kerry
S	Tramore	Waterford
M	Trefriw	Carnarvon
M	Tunbridge Wells	Kent
M S	Tynemouth	Northumberland
M	Upminster	Essex
M	Vicar's Bridge	Clackmannan
M	Victoria Spa	Warwick
S	Warrenpoint	Down
M	Wellingboro'	Northampton
S	Westgate	Kent
S	Weston-super-Mare	Somerset
S	Westward Ho	Devon
S	Weymouth	Dorset
M S	Whitby	York
M	Willoughby	Warwick
M	Windsor Forest	Berks
M	Witham	Essex
M	Withyam	Sussex
M	Woodhall Spa	Lincoln
S	Worthing	Sussex
S	Yarmouth	Norfolk
M	Yarrow	Selkirk

I purpose dwelling chiefly upon our ignorance of the climates of the health resorts. But, before passing to that, I wish to say a few words respecting the literature of the subject. How is it that we have no standard work in which the merits and demerits of all our mineral springs, sea-side bathing-places, and health resorts are impartially set forth?

I am far from ignoring the thousands of more or less ambitious books, each demonstrating that Slowcombe-on-Sea is equally well adapted for a winter and for a summer health resort, that it possesses every natural advantage, and that the sanitary arrangements are perfect. Added to this, there is a gradually rising stream of prospectuses from so-called hydropathic establishments which, without exception, chant the praises of the places whence they emanate. But all these are necessarily, inevitably, one-sided.

And our general treatises, where are they? I may be referred to Sir James Clark's *Sanative Influence of Climate*, an excellent book for its date, but the last edition was issued thirty-four years since, and it only devotes 70 pages to British Health Resorts.

Dr. Granville's *Spas of England*, 3 vols., published in 1841, is far more voluminous, but if the gossip and verbiage were struck out, it would leave little, if any, more information than is given by Sir James Clark; and all of it, be it remembered, is forty years old.

The more recent works, though I do not wish to say anything against them, leave much to be desired. What have we to compare with Lombard's *Traité de Climatologie Médicale*, in three or more volumes? with Dr. von Graefe's *Jahrbucher für Deutschlands Heilquellen und Seebäder?* or with the sumptuous quarto published for several years in Paris with the title of *Album universel des Eaux Minerales, des Bains de Mer, et des Stations d'Hiver*?

Not one of these, however, comes up to my own idea of what is required, and, what is more practical, of what I believe it would pay to publish. In the first place, I do not think that any one person is competent to write the book. Because (and I like to prove each proposition I lay down) it would not be easy to name a person who would command universal respect as (1) a physician, (2) a water analyst, (3) a geologist, (4) a meteorologist, (5) a sanitary engineer, and (6) a statistician. And I hold that a proper, full and true report upon Scarborough, for example, ought to contain data on all these heads, and it ought to give a map (with altitudes) of each town on the scale of at least two inches to the mile, one or two views, and details of the water supply and drainage.

Let me, however, say a few words as to how I think it possible to carry out this scheme to its full extent, and to defray the cost of the, perhaps, half-a-dozen volumes which it would fill.

In the first place, everything should be done to suppress the personal element in the book. It should be brought out under the auspices of some public body—perhaps a committee comprising representatives of the leading Medical, Sanitary, and Scientific societies would command the widest respect. Then there must be one editor in chief, and sub-editors for each of the branches already named. And every paragraph throughout the volume should be initialled, so that no responsibility be shirked.

As the preliminary basis of the publication, an exhaustive series of questions (together with an explanatory note) should be sent to the official representative of each town—the Mayor, where there is one; whom failing, the Chairman of the Local Board; or, in the absence of both, the leading medical practitioner. But these statements would merely serve as a basis; there must be a personal visit by an inspector appointed by the committee, and information must be collected from all possible sources.

As regards the mineral waters, properly attested specimens must be taken of each, and all must be analysed under the supervision of a single analyst, and the results published on a uniform system.

I have not shown how the cost of this is to be met. Probably it would not be more than the sum spent yearly in advertisements by two or three of the largest hydropathic establishments. See, for instance, the hundreds of boards respecting Ben Rhydding at the railway stations throughout the country. Fifty pages of advertisements in the last volume would do no harm to the book, and there is scarcely any price per page at which it would not be profitable to the hydropathic establishments and the larger hotels to insert illustrated prospectuses.

Such a work as this would be a necessity for the consulting physician, and would be of great interest to scientific men; well illustrated, and treating as it would do of many of the most beautiful spots in our country, it would find its way into the homes of the wealthy; and, as the standard authority upon the subject, it would find a sale on the Continent, in our Colonies, and in the United States.

I am aware that I have sketched a large, and perhaps I shall be told a visionary, scheme. Be it so. There is no harm in placing upon record that which is expedient, even if we cannot carry it out at once. We have pointed out the data required, and in the course of time they will be accumulated.

And now for the Climatology. Of course, one essential feature of the work is a full report on the climate of each health resort. I am sorry to say that that is what scarcely anyone can give. This is a sweeping statement, which, of course, I must prove to be true. In the first place, to show you that this is no temporary whim on my part, I ask permission to read a paragraph which I wrote in 1866, and published in 1867 in a little book (long since out of print), entitled *Rain, How, When, Where, and Why it is Measured*:—

'It would be of immense benefit to the medical profession, and the public at large, to know with truth and absolute impartiality the relative climates of our various health resorts: but at present very little is known. There are a host of local treatises on "The Climate of Blankwater," &c., but they are mostly advocates of the place from whence they take their title. We have also some general treatises on the subject, but they are necessarily based on the returns made by persons interested in the popularity of the places in which they reside, and most of them have placed their instruments as well as they know how, but the result is diverse indeed. How, then, can the indications of their instruments be comparable? Moreover, there have been cases strongly indicating a desire to "make things pleasant," by slight departures from impartiality in recording the observations, and hence (unjustly) there is a widespread want of confidence in returns from fashionable health resorts. This should not be. Might it not be removed by the local authorities at each appropriating a small portion of open space to the erection of a set of meteorological instruments, properly verified and properly mounted, and having them regularly recorded by one or more persons? Let the book of observations be always open to public inspection, let whoever takes the observations add his initials, and let the instruments be always readily accessible on application. This proposal might cost each town £10 or so, not more, and it would soon confirm the accuracy of most of those, on all of whom the records of *some* have cast suspicion.'

The great defects of the meteorological observations of bygone years arise from the fact that the importance of absolutely identical methods of observation and record was not fully realised, or, at any rate, was not acted upon. It may have been thought that with a staff of voluntary observers it was difficult to ensure absolute uniformity, that if a paid observer breaks rules the matter is soon rectified, but that when the observer buys all his instruments, and offers of his own free will to send you copies of the observations he makes, it is less easy to obtain strict uniformity. At least, I suppose it must have been so, though my own experience of amateur observers is that they will do almost anything that they are asked. However, whatever may have been the cause, there is no denying the fact that absolutely rigorous identity in the mode of observation is of very recent date. But since getting a Royal Charter, proper offices, and a paid staff, the Meteorological Society has being doing everything in its power towards ascertaining the precise characteristics of English climate. It has now between 80 and 100 stations, with identical instruments, all mounted uniformly, all read at the same instant of local time, recorded and in every respect discussed upon a uniform system, all the instruments tested and verified, and every station visited by the Society's inspector.

A map of the stations and a set of the instruments are now before you. And from the former you will now see what is the deficiency which I wish to see rectified. Take the coast from the Thames to the Land's End. We find the following sea-bathing places without any records being sent to the Society respecting their temperature or humidity :—Herne Bay, Westgate, Margate, Broadstairs, Deal, Dover, Folkestone, Sandgate, Hythe, Hastings, St. Leonards, Seaford, Brighton, Littlehampton, Bognor, Ryde, Sandown, Shanklin, Freshwater, Weymouth, Charmouth, Lyme Regis, Axmouth, Seaton, Exmouth, Dawlish, Looe, and Penzance. Twenty-eight places on the South Coast alone, each doubtless possessing features different from every other, slight probably in some cases—as, for example, Littlehampton and Bognor—but extremely marked in others, as, for instance, Margate and Penzance, or—to take two nearer places—Ryde and Shanklin.

I started by stating that I wished to obtain rather than to afford information. Have I not finished by showing a wide field for useful work ?

G. J. Symons, F.R.S.
President of the Meteorological Society.

Mr. Mitchell held that the scheme proposed by Mr. Symons was not large enough—that it was wanting in completeness. He did not think that it would be possible to obtain one gentleman who could edit the work referred to, and who could also superintend the meteorological readings.

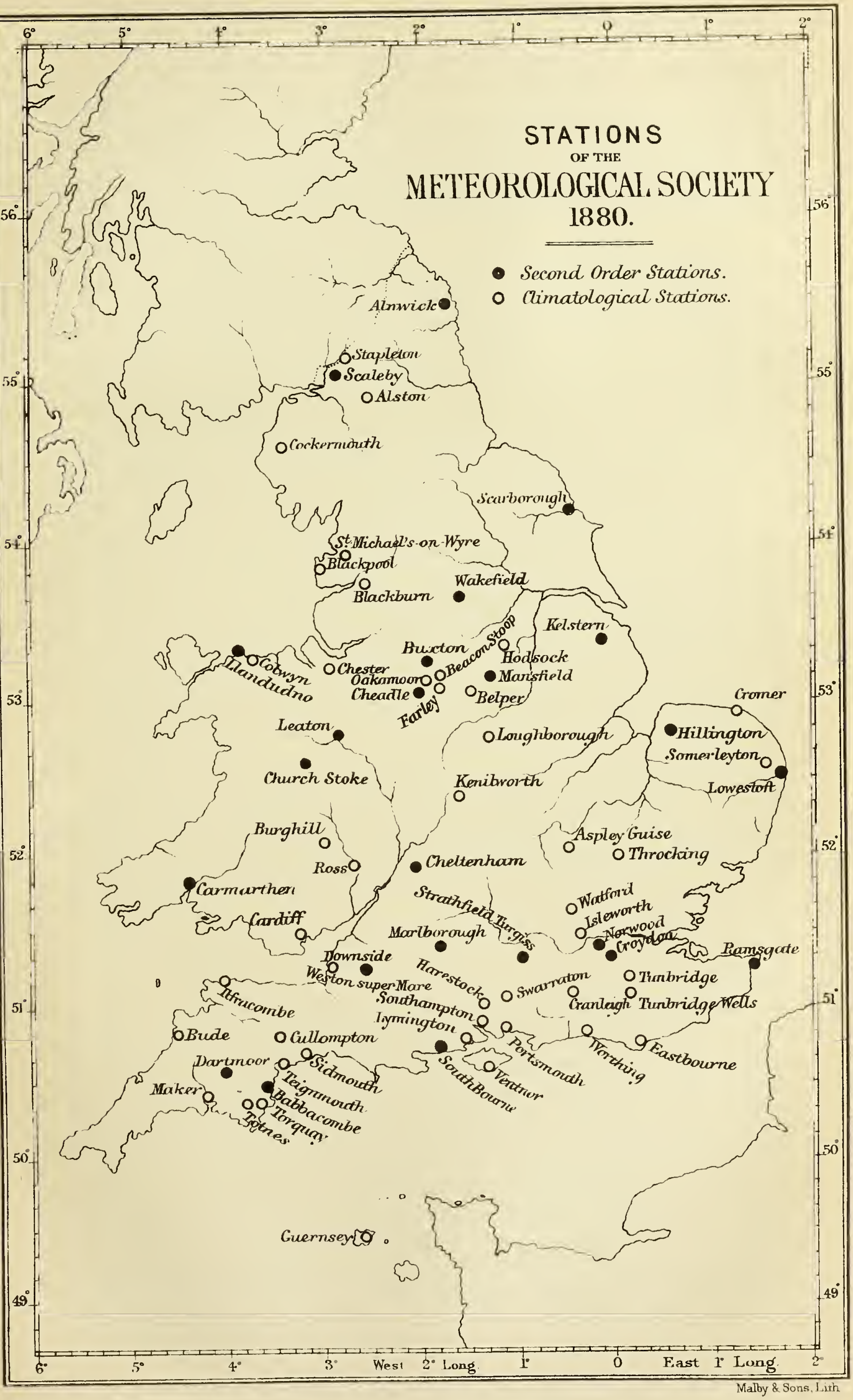
Mr. Symons replied that the qualification referred to by Mr. Mitchell was contemplated by him. (See bottom of page 249.)

Mr. Robins said it would be a great advantage to holiday seekers if they could have a report on the holiday resorts in respect to water-supply and drainage as well as climate.

A vote of thanks having been passed to Mr. Symons, he, in reply to some questions put by Mr. Parfitt, stated that though the colour in the liquid of the minimum thermometer might fade, yet the accuracy of the instrument was not lessened. The speaker also pointed out that there was room for a great deal more information being gathered about health resorts on matters of vital importance.

On the Amount of Organic Impurity contained in the Water of the Exe at Certain Points, in its Course from Tiverton to Stoke Railway Bridge, near Exeter.

Had it not been for the kind co-operation of Mr. Percy Boulnois, the City Surveyor, these experiments would not have been undertaken.



(face page 252)

Mr. Boulnois furnished me with ten of the specimens of water examined by me, and I believe he will have something to say on their collection. I am aware that experiments such as these have been conducted before, and that attempts have been made to exhibit the rate at which the oxidation of organic matter in rivers is effected. First among such experiments are those of Professor Miller, and the observations of Professors Frankland and Tidy, in the same direction, are fresh in our minds.

For the performance of the present set of experiments I have relied on the oxygen or permanganate process, as elaborated by Dr. Tidy. The results obtained have been confirmed by evaporating (with certain precautions) a known volume of water, burning the residue, determining the amount of CO^2 evolved, and from this calculating the proportion of organic carbon. For this purpose I have employed a modification of Professor Dittmor's method, described by me in the July number of the 'Analyst.' I will now call your attention to the annexed table exhibiting the results obtained, the amount of impurity being expressed as 'oxygen consumed,' or 'organic carbon yielded,' by 100,000 parts of water. Dr. Frankland, in his new work on water analysis, has called attention to the relation existing between 'oxygen consumed' and 'organic carbon' as exhibited in the waters of the Thames and Lea. The figures obtained in these analyses confirm this relation in regard to the Exe. The constant multiplier for the conversion of 'oxygen consumed' to 'organic carbon' is found by averaging the second line of figures.

Dr. Frankland's experiments gave 2·38, while these give 2·61; the difference is probably due to less delicate manipulation on my part.

Starting a mile above Tiverton, we find the water of medium purity; No. 1 requiring ·0718 parts of oxygen to oxidise its organic matter. About 100 yards below Tiverton, after the water has been polluted by the sewage of the town, and has passed through the mills, the amount of oxygen absorbed is—as might be expected—larger, being ·0873.

At two miles below the town it is still more polluted, and the amount of oxygen it now takes is ·0929.

After flowing over a stony bottom, and just above Bickleigh bridge, in still water with plenty of weeds, we find the organic matter considerably reduced; the proportion of oxygen consumed being ·0738. Passing on to that taken below Bickleigh mill-stream, the amount of impurity again increases; for the quantity of oxygen required is ·0859. But the cause of this is at once apparent. The water of the Dart, which flows into the Exe, about one mile above the place from which the previous specimen was taken, is very foul, requiring not less than ·207 of oxygen for the oxidation of its organic matter. The water now passes over a gravelly bottom, and ripples over natural weirs, and at Bourne mills, just below the junction of the Bourne, the water becomes much improved in quality. At Thorverton it appears to be again slightly fouled, but recovers itself by the time it reaches Nether Exe, after flowing over a weir. At Stoke railway bridge the river is much deeper, and is not quite so pure.

There are two points gained in this examination.

1st. That were it not for the dirty river Dart, the water supply of Exeter would be much better than it is.

2nd. That Nature's process of oxidation, as carried on in rivers, is, under favourable circumstances, anything but slow. Let but the water tumble over a weir or ripple along a stony bed, or let there be an abundant growth of plants, and we find, even in a short course, a great change for the better. This is well illustrated in the flow of the river from the Dart to above Thorverton, where the bed is rocky.

Even at Tiverton, after the water is churned up by passing through the mills, it must come out purer than it went in; for water taken at the point where the sewage is delivered into the river would be much more contaminated.

In the deeper parts of the stream, oxidation seems not to be so rapid.

No laboratory experiment, however skilfully devised, can ever approach Nature's process. Here is a river, open to the air, and subject to the variable yet constant action of heat and light. The supply of air is unlimited, and changing momentarily; every breeze that is wafted over the surface of the river bringing the purifying oxygen in contact with the effete matter, and every ripple showing its decomposition. The constant evaporation from the surface, and the continual molecular change that thereby ensues, must be the means of breaking up organic compounds, and also aid materially in purification. The old saying, then, that 'running water purifies itself,' is true; but for rapid purification, the water must be brought into close contact with the air or with oxygen. I conclude these notes with the remark that, although the Exe is not perfection, it is not the sewer some imagine it. As it is, it bears favourable comparison with any of the rivers of the kingdom; and when its water is carefully filtered it reaches a high standard of purity.

Specimens of Water from the Exe.—Amount of Organic Impurity in 100,000 *parts.*

No.	Where obtained	Oxygen consumed	×	$\frac{C}{O}$	=	Organic Carbon yielded
1	One mile above Tiverton	·0718	×	2·27	=	·163
2	Below Tiverton	·0873	×	2·81	=	·246
3	Two miles below Tiverton	·0929	×	2·93	=	·273
4	Above Bickleigh bridge	·0788	×	2·41	=	·190
5	*The Dart*	·2070	×	2·11	=	·436
6	Below Bickleigh mill-stream	·0859	×	3·16	=	·272
7	Bourne farm below the stream	·080	×	2·7	=	·218
8	Thorverton *above* the weir	·0831	×	2·6	=	·218
9	Nether Exe	·080	—	—	—	—
10	Stoke railway bridge	·0831	—	—	—	—
11	Dane's Castle Works	·0715	×	2·29	=	·164
12	From service-pipe supplying laboratory	—				

Frank P. Perkins,
Public Analyst for the City of Exeter.

Mr. H. P. Boulnois said he desired to add a few remarks in addition to Mr. Perkins's valuable paper. The samples of water to which Mr. Perkins referred were taken by him on August 16, 1880, the water in the river being abnormally low. In taking the samples he noted the velocity of the flow of the water, the character of the bed of the river, the appearance of the water, its depth, and other particulars, which he would describe. The samples were all taken from as near the centre of the river as possible, but unfortunately he had no appliance with him for registering the temperature of the water. The fifth sample referred to was taken from the stream called the Dart, near its junction with the Exe at Bickleigh Bridge, its velocity at this point being at the rate of 3·2 feet per second, depth 6 inches, the bottom, which was of a gravelly, stony nature, being covered with a slimy, dark deposit or vegetation, giving to the water a grey, dark hue. This description gave an idea of the appearance of the stream and of the small rivulets joining it for about three miles above the confluence of the Exe. This stream rose on Gibbet-moor, on the outskirts of Exmoor, and close to it rose the Little Dart, which flowed westward, but both these streams were quite distinct from the well-known river Dart, and were not to be confounded with it. The stream from which the sample in question was taken flowed S. and S. by E. till it joined the Exe. It passed, apparently, exclusively through pasture land according to the Ordnance Map, and could not receive an amount of contamination from dwellings sufficient to give it the bad character Mr. Perkins had assigned to it, no populous place being in its vicinity. The presence of such an excessive amount of organic carbon must, therefore, be due to peat. He had not yet had an opportunity of inspecting this stream throughout its entire length, but he should be now tempted to do so after hearing Mr. Perkins's paper. With reference to the attack on the water-supply of Exeter made in the letter from Dr. Bankart (See *ante*, page 240), Dr. Bankart complained of the source from whence the water came, and that Tiverton drained into the Exe. The paper just read, he thought, clearly proved by actual facts that the water of the Exe, as supplied to the inhabitants, was as pure as it could possibly be expected to be. There was no doubt that a large comprehensive gravitation scheme for bringing water from either Exe or Dartmoor would be a great thing for the city, but it would probably cost over 100,000*l*. With reference to the question of a constant supply, he, and he believed the whole of the Town Council, were anxious to see this boon granted to the city; but the matter, to a certain extent, rested with the citizens. In some districts he had discovered waste to a certain extent of 75 gallons per head, and it was impossible to give a constant supply whilst that waste continued. Bye-laws, however, had been prepared to meet the case, and only needed confirmation; but he was afraid they could not get it until they were ready to give a constant supply, which they could not do until the waste was stopped.

The President said it was only fair to give Mr. Boulnois an opportunity of answering the letter, but he observed that the letter said, in spite of bye-laws, the Exe river received at one spot the excreta of several thousand people.

The SURVEYOR admitted that the sewerage of Tiverton discharged into the river.

Mr. SYMONS said the Town Council had only to put the law in force to compel the people of Tiverton to refrain from doing this.

Mr. J. DAW said he must give the people of Tiverton credit for one thing. They had lately brought water into the town so as to flush their sewers and purify their town by washing all the sewage into the Exe.

Mr. S. JONES (Sheriff of the city) thought that before the citizens came into court it would be necessary for them to have clean hands themselves.

Mr. W. MORTIMER said the circumstances of Tiverton and Exeter were different. Exeter was situated at the outlet, and there was no supply taken from the river below the city. One of the reasons why the authorities had not found a remedy for the water-supply before was the belief, which he hoped the discussion of that day had dispersed for ever, that there was a sufficient supply beneath their feet.

A vote of thanks was then accorded Mr. Perkins for his paper.

On the Ventilation of Water Mains.

IT will be conceded, I presume, that given a certain collection of good water in a tank or reservoir, it is equally pure whether it be discharged into a constant service system or an intermittent one, and also that the dangers inherent in an intermittent water supply have so far nothing to do with the water itself—only with the system—thanks to the imperfect details which are still permitted to be carried out and the evil results of present faulty systems.

The question is, how to obviate these dangers, if possible.

The great danger of the intermittent system arises, *cœteris paribus*, from the tendency of the system, when the supply is turned off, to produce in the water mains and service pipes a partial vacuum, the result being that these mains and pipes become rapidly filled by suction power, or, I should say, by the external pressure, with a leakage of air and soakings from more or less impure sources.

Were the mains and service pipes and taps all good and efficient, this leakage would not be so dangerous; but, unfortunately, they are not, and we must take things as they are. The whistling sound of the air rushing back through the house tap into the service pipes when the supply is cut off is, I am afraid, only too familiar to most of us. When this occurs in a sink tap, or a direct service closet tap—for such things continue to exist under the conservative energy of too many sanitary authorities in their efforts at local government—when such occurs, I say, we, as sanitarians, know only too well what the risk is—the absorption of foul gases into the water, rendering it a suitable fluid for the production of diarrhœa, enteritis, or fever. Now

I would propose to combat this great danger of the intermittent systems by ventilating the main or mains from above, and by introducing a V-shaped pipe, as an anti-suction valve, at the junction with every house pipe or other outlet.

We will take the latter first. Where the water supplied is previously filtered, it may consist of a simple bent pipe giving a dip of, say, a foot. In small towns and villages where the water is supplied unfiltered from a large collecting tank or reservoir, and where the water frequently carries with it a certain amount of grit, the bottom of the V-pipe would of course, in time, be liable to get filled up and stop the supply. To obviate this, in such cases, I would propose that at the bottom of the V there should be a screw plug for cleansing and washing out any deposit brought down by the water.

For ventilation of the water-main from above, I would propose, at a point immediately below the cut-off cock, to introduce a ventilating pipe which could be led up the side of a house or be fixed to a post, as convenient, at such a height and in such a position as to admit pure atmospheric air. At a convenient distance above the ground, say 5 feet, a box or chamber would be interposed in the pipe containing a floating valve, so fixed as to close the ventilating pipe when the water was turned on, thus preventing any waste; when the water was turned off, and the main began to empty, the valve would fall, and admit pure air to the mains and pipes

Such is the plan; and it requires, I hope, but little explanation. While the ventilating pipe at the head of the main will admit a free supply of fresh air to the system, the V-pipes, being full of water, will prevent the admission of any air or gas from houses or closets or any outlets of the water system.

It will still be possible, of course, to have a leakage of impurity from the surrounding soil through a hole or fault in the main, but as this must also lead to a leak of water *from* the main, it is likely soon to be discovered.

The ventilating pipe without the V-pipes would not suffice; for when the water had run out and the system was filled with air, the temperature of the dwellings and underground being greater than that of the atmosphere, we should soon have a backward current of air established, with the consequent risk of the inhalation of impure gases.

It has become manifest in the present day, that, both in our national foreign policy and our private domestic affairs, economy must be a ruling principle in all things; and thus we find that, in many instances, a constant water supply is necessarily vetoed on account of the expense. It remains, then, for science to help "the powers that be" out of the many difficulties which finance imposes upon them. I lay my first-born before you with fear and trembling, but not altogether without hope.

F. L. Stephenson, M.B.

Mr. Boulnois said he had listened with great interest to the paper. In the present intermittent system that prevailed, on account of the cost of a continuous one, it was frequently necessary to empty the mains as described, and no doubt foul air entered them. He considered the 'V' pipe or syphon a good idea, but with regard to the elaborate process for ventilation, he thought it could be dealt with by means of ball-hydrants.

Mr. Stephenson, in answer to a question, said that he proposed to put the 'V' syphons in every house, otherwise the people would not do right.

Mr. Boulnois said they could get bye-laws made.

Mr. Stephenson said they could not get bye-laws enforced in small districts, the authorities being afraid of their powers.

Mr. Grantham also thought the pipe proposed would be good, but he doubted the ventilation.

A vote of thanks was accorded Mr. Stephenson for his paper.

At the conclusion of the section a vote of thanks was given to the President.

CIRCULATION OR STAGNATION

BEING THE TRANSLATION OF A PAPER BY F. O. WARD

ON THE

ARTERIAL AND VENOUS SYSTEM FOR THE SANITATION OF TOWNS

WITH A STATEMENT OF THE PROGRESS MADE SINCE THEN FOR ITS COMPLETION

BY

EDWIN CHADWICK, C.B.

LATE CHIEF EXECUTIVE OFFICER OF THE FIRST GENERAL BOARD OF HEALTH

PREFACE.

In my report on the sanitary condition of the labouring population of Great Britain, in 1842, I made the following statement of information, the result of extensive inquiries:—'Within many of the towns we find the houses and streets filthy, the air fœtid, disease, typhus, and other epidemics rife amongst the population, bringing in the train of these conditions destitution and the need of pecuniary as well as medical relief, all mainly arising from the presence of the richest materials of production, the complete absence of which would in a great measure restore health, avert the recurrence of disease, and, if properly applied, would promote abundance of production, cheapen food, and increase the demands for beneficial labour. Outside the afflicted districts, and at a short distance from them, as in the adjacent rural districts, we find the aspect of the country poor and thinly clad with vegetation (except rushes and plants favoured by a superabundance of moisture), the crops meagre, the labouring population afflicted with rheumatism and other maladies, arising from damp and an excess of water, which excess, if removed, would relieve them from a cause of disease and the land from an impediment to production, and if conveyed for the use of the population would give that population the element of which they stand in peculiar need, as a means to relieve them from what is their own cause of depression, and return it for use on other land as a means of the highest fertility.

'Later investigations have established two general conclusions applicable to the subject: That in towns all offensive smells from the decomposition of animal and vegetable matter indicate the generation and presence of the causes of insalubrity, and of preventable disease, at the same time that they prove defective local administration.

'And correlatively that in rural districts all continuous offensive smells from animal and vegetable decomposition indicate preventable loss of fertilising matter, loss of money, and bad husbandry.

'Of the first of these propositions any one may convince himself who will visit the spots most frequently afflicted with typhus and other epidemic and endemic diseases, where he will find that his own sensations, without any other direction, will commonly indicate the chief seats of insalubrity. Such indications are given by the sickening sensations occasioned by breathing air rendered impure by the admixture of organic vapours arising from decay, as well as by pungent and offensive stinks; for though the stinks always indicate danger, it does not follow that there is no danger when there are no such warnings. The danger is often greater from foul air, which less strongly affects the olfactory organs.'

The engineering and mechanical means for effecting these objects, of which I had made a long study, constituted an arterial venous system of sanitation for the relief of populations, and were comprised in various papers, first at the Consolidated Commission of Sewers for the metropolis and the Metropolitan Sanitary Commission, but chiefly in the report of the first General Board of Health in 1850 on the supply of water to the metropolis; then in the 'minutes of information on the drainage of land'; and the 'minutes of information on the drainage of houses and towns'; and the 'minutes of information on the practical application of sewer water and town manures to agricultural production' issued by that Board in 1851. This system so developed was early comprehended by the late Mr. F. O. Ward and ably expounded by him, when attending with Lord Ebrington (now Earl Fortescue) as delegates at the Congress on Hygiene held at Brussels in Sept. 1852. By my wish he abstained from mentioning myself, as it would give the opportunity of attacks on the principle by attacks on the person propounding it, as is the common practice. But that reason has very much passed.

Reference was made at the last International Congress held at Paris, to Mr. Ward's exposition of the system at Brussels, where it appears to have been followed with good effects. But the principle of the unity of the works in question, so needful for their efficiency, is as yet so little understood, that it is of importance to take occasion to republish his popular exposition of it, with the addition of what may be taken as a varied exposition of it as it is presented to my view at the present time, comprising the chief points of progress in sanitary art and science for its completion since it was first made.

EDWIN CHADWICK.

EAST SHEEN, SURREY,
Oct. 1880.

In answer to the announcement that I proposed to republish the paper read at the Congress on Hygiene at Brussels, where Earl Fortescue was present and took active part, I have received the following note from his lordship :—

'Castle Hill, North Devon: *Oct.* 6, 1880.

'My dear Chadwick,—I rejoice that you should have thought of reproducing in English the very able exposition by our early friend and coadjutor of the leading principles of sanitation, principles long ago vindicated by him in speeches made in a foreign language and in a friendly foreign capital, to which I remember listening at the time with sympathy and admiration.

'Subsequent experience seems to have confirmed the general soundness of the conclusions which he so pointedly set forth in his little French pamphlet more than a quarter of a century ago, but which, in the present state of uncertainty and confusion of the public mind, seem to be still treated as debatable questions, instead of truths arrived at both by deduction from first principles and induction from a constantly increasing body of satisfactory experience. I say "general soundness," because it can hardly be affirmed that as regards agriculture the diffusion of sewage manure through pipes has hitherto been profitably carried on at the distance from towns or to the extent anticipated by yourself and by our somewhat oversanguine friend; though in particular cases where the rainfall has been excluded, where the length of the tubular channels has been moderate, and the work has been carried on with practical agricultural skill and with due attention to economy, the system has been proved, and will yet, I believe, increasingly prove, profitable.

'I trust his vivid description of the Circulating System, with your notes and additions, may have a wide circulation, such as the importance of the truths therein set forth deserves. For, such is the amount of prejudice and real or supposed self-interest arrayed against them, that they require constantly reiterating, and their practical influence upon the weal as well as wealth of the community again and again brought home to the public mind.

'Heartily wishing you success in this renewed effort to diffuse the sound doctrines which you began promulgating very nearly forty years ago, I remain,

'My dear Chadwick,

'Yours sincerely,

'FORTESCUE.'

PREFACE BY THE EDITOR

TO

THE BELGIAN EDITION OF THE PAPER.

'*Circulation or stagnation?*' Such is the neat and concise form in which Mr. F. O. Ward and his colleagues have just put the sanitary question before the Congress of General Hygiene at Brussels.

In reproducing under this title the two principal speeches of this sanitary reformer, we believe that we shall render a service to all who are interested in this great cause—the cause of humanity at large.

Continuous circulation is the fundamental principle of English sanitary reformers. According to their theory, the main conveyance of pure water into towns and its distribution into houses, as well as the removal of foul water by drains from the houses and from the streets into the fields for agricultural production, should go on without cessation and without stagnation either in the houses or the streets.

Hence they would do away altogether with cisterns and cesspools, which Mr. F. O. Ward designates as 'two congenital forms of pestilential stagnation;' and wherever the double movement of water and sewage is hindered by the flatness of the land, they maintain complete circulation by steam power. It is at this last point especially that, according to Mr. F. O. Ward, the new system of drainage coincides with the general progress of the nineteenth century.

'*Hygiene* by steam power' (we quote his exact words) 'is at once the logical extension and the necessary complement of *locomotion* by steam power, which has of late been organised throughout the whole of Europe. The steam engine, which has already quadrupled the means of transporting products from one place to another, will now quadruple the produce of the matter transported. This new application of the great invention of Watt will before long effect the same happy and astounding transformation in our domiciliary and agricultural arrangements as it has already produced in nearly all the other branches of industrial art.'

As to the method of thus applying steam to the service of public hygiene, it consists chiefly in the establishment of a vast tubular system. Mr. F. O. Ward has given us a rapid sketch of the physiological analogies and material organisation of such a system. In the words of this eminent sanitary reformer: 'the discovery by the immortal Harvey of the circulation which goes on in the individual body has prepared us for the reception of the strictly analogous and fruitful discovery of the circulation in the social body.'

Conceptions such as these, based as they are on numerous experiments and very positive results, deserve undoubtedly the impartial investigation which Mr. F. O. Ward and his colleagues solicit.

Let, then, these conceptions, these experiments, and these results be carefully examined. Let the press and the public join in the discussion of them. The scheme proposed to us is no less than the reconstruction, on principles of a very bold nature, and hitherto but little known, of the material bases of civilisation.

What answer, then, must we give to this question, so concisely formulated, and apparently so simple, but of which the scope is immense:—'Circulation or Stagnation?'

GENERAL CONGRESS OF HYGIENE AT BRUSSELS.

FIRST MEETING, SEPT. 20, 1852.

ADDRESS OF MR. F. O. WARD.

'Gentlemen,—Before we separate, I beg permission to bring before you very briefly the chief point of the new sanitary system—the system of circulation as opposed to stagnation—which we are here, my honourable friend Lord Ebrington and myself, to submit to your consideration. I shall not be able to treat the whole of the subject in one discourse, nor even in the sub-sections of the four sections in which we carry on our deliberations, and of which I have been obliged, according to rule, to choose one part to the exclusion of the three others. I beg you, therefore, to accord me your attention for a short time. (From all parts: 'Speak, speak.')

Gentlemen, this new system upsets many old ideas, in order to replace them by principles which, taken all together, constitute an entirely new combination.

Thus, for instance, this system, of which the fundamental basis is the incessant circulation of the water, which enters a town in a state of purity, and the equally continuous motion of the fouled water which leaves the house and the town, admits neither cisterns nor cesspools, which are, as before stated, two congenital forms of pestilential stagnation.

Furthermore, this system, which has for its object not only the carrying away of the fertilising matter which hitherto has been allowed to remain for a longer or shorter period in the midst of human habitations, but also the application of this matter to the use of agriculture, and its transformation from a source of disease and expense into one of riches and nourishment. This system, I say, does not allow (unless provisionally) the discharge of excrement into rivers—a process which we regard as deplorable waste.

To prevent this waste, and to replace it by fruitful circulation, we connect towns and country by means of an immense tubular organisation consisting of two divisions, the one the urban drainage, the other the rural distribution; and these two divisions are again subdivided into two distinct parts, the one arterial, the other venous.

Thus, we construct in a town two systems of pipes, the one bringing in pure water, the other carrying off this water enriched by fertilising matter.

In like manner, too, we lay down two systems of pipes in country places, the one for irrigation, which takes the fertilising fluid to the crops, the other for drainage, which carries off the water after it has filtered through the soil, and which, if allowed to remain any length of time, would make the land marshy.

In the middle of these four systems of pipes we place a motive organ—a central heart so to say—in one word, a steam engine, which sets the whole system in motion.

Thus, at last we see the sanitary movement and the agricultural movement, after having long pursued their development in separate though parallel paths, meeting and blending in one great movement. It is from this union that has resulted the vast tubular organisation of which I have just described the broad outline, which is new, and of which I am about to point out to you some of the principal details, which are equally new.

And first, gentlemen, let me give you a few rapid hints on the difficult question of the source and of the collection of the water, the fluid which is to circulate in these arteries and veins—the blood of this immense organism.

Our system does not admit as suitable sources the rivers from which the water of towns is usually supplied, nor even the subterranean springs which feed our wells.

According to our experience river water is always more or less impregnated with organic and mineral impurities taken up from the fields which it washes, and the towns and villages through which it passes.

The water of subterranean springs holds likewise in solution particles of all the soluble minerals which it meets with on its way through the ground.

We leave, therefore, the beds of valleys and the bottoms of wells, to seek near the summit of hills pure water which has been distilled by the sun, and has descended afterwards in the form of rain, either on the primitive rock, or on its gravelly débris. When the rock fails to supply our wants, we go to sterile regions—to heath lands, where we know that we shall find pure water, our *liquid* food, precisely because not containing soluble salts they are incapable of providing corn and meat, our *solid* food.

There, in the silicious gravel which has been washed and purified by centuries of rain, we lay down tubes of burnt clay, or large channels of permeable bricks or tiles, most commonly three, four, or five feet below the surface (according to the conditions of the strata), and these pipes collect rain-water which has attained its highest point of purity by filtration through the upper stratum, generally pure sand.

Just as an aqueduct represents an artificial river, so these tubes may be regarded as artificial sources—a rural prolongation of the aqueduct, accomplishing for the collection of water what the urban prolongation has long since done for its distribution. We might call it the capillary system which brings water to each house.

I come now to the second part of our metropolitan system—viz. the carrying off of this water with the excreta with which it may be charged, a process which, in our opinion, requires equally bold innovations. We abstain from the great and costly Roman constructions, nowadays so much vaunted by old engineers for metropolitan tunnel sewers. We do not admire these vast subterranean galleries, which with their slow current and their putrid accumulations are nothing more than extended cesspools. We would replace these semi-stagnant large conduits by small earthenware tubular pipes, concentrating the smallest flows, so as to carry away all the matter removable by water-carriage as soon as it is produced, at sufficient velocities, usually two or three miles an hour, thus removing it from the town where it would become pestilential, into the country, where, properly applied, it is of the highest efficacy in production.

We would have no more emptying of cesspools and cleaning out of drains by human labour. We would suppress for ever such degrading occupations, and where the levels and gravitation fail we look to steam to supply the inclinations and velocities.

Is it not indeed evident that steam power, which will lift a ton of water to a height of a hundred feet for less than a pennyworth of fuel, can replace human labour as economically in the clearing out of drains as it has already done in weaving and other industrial processes?

Let us now cast a rapid glance at the agricultural part of our system. The same reformation is called for here, on the same principle—circulation; by the same means—steam-power; with the same results—economy and health. Manure, henceforth no longer toilsomely distributed by the hard labour of men and horses, will be driven in a liquid state either through iron or earthen pipes, or led to flow by a prepared surface irrigation made of cast-iron, where gutters dug for the purpose cannot be used, and it may in some cases emerge through a flexible pipe and fall on the ground like artificial rain. By this means a man and a boy would be able to water no less than twenty acres a day. So much for the first part—the *arterial* division of the agricultural system.

With regard to the second part of the process—the final carrying off of the water by drainage—here, too, in default of natural gravitation, steam power now comes to our aid. For just as steam-pumps dry up marshes at an annual cost of four or five francs per 100 acres, so at an equally small cost will they carry off the superabundant water, which, after having deposited its manurial matter in the soil, filters into our drains. These drains then conduct it, purified by filtration, to the rivers, where it finally discharges itself in as clear and sparkling a state as when delivered from the hill-top.

Thus in the country, as well as in towns, we are easily able with the help of steam to master the difficulty which has hitherto been such a formidable obstacle both to the sanitary and the agricultural engineer—viz., the absence of slope to assist the running off of water.

And do not, gentlemen, allow yourselves to be alarmed by the expense of establishing this new system, which may be called hygiene by steam power. The service of pure water in towns can be organised for a sum represented (all expenses included) by a payment of 2*d.* a week from each house; and the construction of tubular drains with the steam-engine and all accessories, would be covered by about the same weekly expense. Tubular organisation in the country is even cheaper than in towns. It costs no more than 5*l.* to 8*l.* per acre for the system of irrigation, and 8*l.* to 10*l.* per acre for the system of drainage. I shall, I hope, have an opportunity of proving to you in detail that the new system may be organised at an absolutely less cost than the old one, while at the same time it is more productive. I shall, for instance, demonstrate to you that the mere proceeds of the sale of our discarded pumps and cisterns would not only pay for the machinery of the new system of distribution of water in our towns, but that we should remain with a surplus in hand—a direct and immediate benefit of the innovation.

But, gentlemen, if this were not the case, if the costs of this new system were very great instead of being very small, the diminution of the costs of maintenance in towns, and still more the enormous increase in the products of the country, would very soon reimburse us for our first outlay.

In one of the farms already worked on this principle in England, the annual yield of hay has already risen from twelve stacks, which it amounted to in 1848, to eighty stacks.

In another case, in Scotland, a barren tract of sand which was formerly valueless has produced, since the application of steam irrigation, 20*l.* per acre annually.

I have thus no hesitation in saying that steam-power, after having quadrupled our means of transporting products from one place to another, will eventually, by the new application which we propose to make of it, quadruple the produce of the matter transported. *Hygiene by steam power* is thus both the logical extension and the necessary complement of the system of *locomotion by steam power* which Europe has lately adopted.

The scheme we are proposing is in fact nothing more than an adaptation of the great invention of Watt, to bring about in our domiciliary and agricultural arrangements the same happy and astounding transformation as it has already effected in nearly all the other branches of industrial art.

Such, gentlemen, is in general terms a description of our new system, each part of which rests on positive facts—facts, I may add, acquired by long and costly experience.

The water which falls on the hills in a state of purity, undergoes a natural process of filtration through sand, enters the rural collecting-pipes, and passing through the aqueduct to the metropolitan distribution pipes, finds its way to every storey of every house in the town; whence again, after having supplied the wants of the inhabitants, it runs off, enriched with fertilising matter, which it carries away before allowing it time to ferment. This manure, driven along irrigation pipes, is deposited in the soil, leaving the water to pass into drainage pipes, and flow on to the rivers. The rivers conduct it to the ocean, whence it rises as vapour under the heat of the sun, to re-descend as rain on the hills, enter again the collection pipes, and recommence its vast and useful course of circulation.

We hope by more detailed explanations in section to induce you to study this system seriously, and, after a thorough investigation, to adopt its fundamental principle—circulation instead of stagnation."

SUBSEQUENT PROGRESS OF THE PRINCIPLE OF CIRCULATION.

In a number of provincial towns, where works have been conducted on the principles promulgated by our first general Board of Health, the principles set forth on the arterial and venous system have been carried out more or less perfectly, but so far as completely to establish the principle :—as, for instance, in Croydon, Bedford, Cheltenham, and Leamington, amongst others. In these towns the fresh water is carried into all the houses;—the fouled water, with putrescent matter, carried out from them through self-cleansing drains and self-cleansing sewers, and that fouled water, or the water containing liquefied manure, is carried direct on to the land. In most of them, the whole excreta of the morning is removed within an hour or two, and by the afternoon is deposited on the land, not in mechanical suspension, but in chemical combination. The most complete study of the principle was given by M. Holbrecht, and the German engineers, and it is in the course of application for Berlin. In the provincial towns in England where it has been the least incompletely carried out, the reductions of the death-rates have been from one-fourth to one-third of the previous rates, with as yet few, if any, of the collateral aids which sanitary science may yet make available, as the prevention of over-crowding as in common lodgings, and better warming and ventilating schools, medical inspection of the scholars, and systematic appliances for personal and household cleanliness.

Water and Stagnation.

I beg now to repeat for the sake of connection that, as will be seen in our reports at the time when the system was first propounded, the rural population, whether living in detached cottages or in villages, were, as they are mostly now, generally supplied by well water. Unless the surface of the wells be deep, such water, by stagnation, imbibes floating particles of vegetable or animal matter, and is deteriorated by stagnation. It is also rendered additionally impure by soakage from cesspits or from house-drains. It is seldom wholesome, and often dangerous to drink. The population either drink tea, which makes the water safe by boiling, or they drink beer. It is rare for any collection of rain-water to be made. For large towns, the practice of engineers has been to collect supplies from the nearest river sources. These, like the greater part of the supplies of London, are more or less polluted, by the surface-washings of lands, often of highly cultivated lands heavily manured with putrid manure, and also by the sewage from ill-drained houses. In some instances the supplies are derived not from rivers but from lakes, and obtained from the surface washings of uncultivated uplands, from granite, slate, or sandstone grit. In these instances there is less of impurity from these than from river sources; the chief impurities being in winter time from infusions of peat, which is apt to produce dyspepsia and diarrhœa.

The Aëration of Water.

But the aëration of water as affected by stagnation has not yet been taken into proper account, or completely examined specially as affecting the potability of water.

Failure of Common Artificial Filtration.

The supplies taken from rivers might be very well aërated, particularly that derived from spring sources; but it is taken into subsidence or storage reservoirs, where it is detained in a stagnant condition, and to a considerable extent de-aërated by stagnation. Algæ and other aquatic vegetation are rapidly developed, and almost as rapidly die and animalcules appear; and if the stagnation is prolonged in open reservoirs, putrefaction of vegetable and animal matter, and marsh miasmata, arise. The next stage is removal to filtration-reservoirs, which removes most of the solid matters which the subsiding reservoirs may have generated or absorbed. Thence the water is carried to the towns, where, under the intermittent systems of supply, it is again kept in a condition of stagnation in cisterns, and absorbs the air, whatever may be its quality, surrounding the cistern. The first filtration by large reservoirs, a first sieving, does not usually dispense with a second filtration :—that is to say, a second or final sieving is given. For a few days, a charcoal filter may be a little more than a sieve, but unless frequently renewed, it will be no more than a sieve. The water, by repeated filtrations, is rendered perfectly transparent, and being so, is commonly received as pure, but the microscope now detects animalcules of species denoting impurity, and demonstrates that clarification and purification are widely different.

But for the great mass of the population there is no second filtration. For those in the metropolis, and throughout the country where the supplies are intermittent, there is stagnation in butts and cisterns, and situated as these cisterns are in close courts or alleys, sometimes directly over cesspools, or having overflow pipes into sewers which are sewers of deposit or extended cesspools, they rapidly absorb the noxious gases of decomposition, and the purest of the supplies from spring sources become dangerous to drink at certain seasons. It may be said that in drinking water taken, if it be, direct from mountain springs, the taste is refreshing, for the people are drinking mountain air;—taken from mountain sources, after stagnation in cisterns in middle-class dwellings in town, the taste is flat, for they are drinking town air;—taken after stagnation in butts, in close courts and habitations, near to cesspools, it is mawkish or nauseous, for they are drinking cesspool air. From the conditions in which the majority of the population in towns are placed, the deaërated or the mal-aërated water is not habitually drunk by them, but only tea or beer.

The great remedy is the avoidance of stagnation at every stage, by taking the water direct from its source, and, wherever it is practicable, by taking it from a natural or an artificial spring source.

Natural Filtration.

The conception of the proper artificial spring sources naturally occurred to me in the study of the drainage, by permeable tile drains, of lands surcharged with moisture.

To the extent of their depth, wells may be regarded as vertical earth filters; but the permeable land drains may be considered as longer *horizontal* earth filters. They may be regarded as filters some hundred yards long, as against the well filter of two or three yards deep. The vertical filter is uncovered, and exposed to light and accidental pollution, but the horizontal filter is covered, and protected for its whole length. Where the horizontal filter can be carried through a pure sand, with only a light amount of vegetation and without cultivation, the water derived is even purer than rain water, as the filter takes out any floating spores or particles that the rain imbibes. These are effectually removed in passing through the filter of a yard or so in thickness and the roots of the vegetation which may permeate the stratum. Water so collected, having had the best of filtration, through long surfaces, needs no second filtration, and is highly aërated, and, collected at once and delivered direct into the houses as it may be, it is cool and refreshing, often effervescent, and equal to the spring water obtained from the best springs at any of the health resorts. We proposed, as stated, an improved supply of water on this principle for the metropolis from the Surrey sands, from which it was evident that a supply amply sufficient was available for the then population of the metropolis. The engineers of two of the companies have recently struck upon this method of collection,—Mr. Taylor, of the Lambeth Company, and Mr. Fraser, of the Grand Junction Company, and though it has been from inferior strata, yielding only a harder water, the water derived is deemed the purest of any yet obtained in the metropolis. It is stated to be so remarkably pure, so far as the works have yet been carried, as to need neither primary nor secondary filtration, and has the most complete aëration for direct distribution. The method of collection has been applied with success for Brussels, and by long conduits (open for economy there) through sand strata for Amsterdam, by Mr. Quick. It is also successfully applied for Dresden, and is in the course of application by the engineer, Holbrecht, of Berlin, who is following closely our principle as devised for the metropolis. Of course, the mineral quality of the water derived from this method of collection will vary with the strata; and that derived from some of the sands is hard. But the constants of the principle are complete and final filtration and good aëration, and superior potability. Of late, the method of softening waters, whether on a large or a small scale, has been greatly improved. It was stated by M. Jager, at the Congress on Hygiene, that during the last attack of cholera in 1866, different results were found to attend different supplies of water:—well water, river water, and other water. During the epidemic, the authorities of Rotterdam changed the supplies to a purer source, with an immediate reduction of the deaths by one-half, and while the deaths in the districts supplied by well waters were at the rate of 16·8 per 1,000, and of the river waters 11·9 per 1,000, the death-rate at Amsterdam, supplied from the horizontal, sand-filtered collection, was the lowest of any, being only 4 per 1,000—a comparative result which, from what I saw of the works, I should expect from them.

Steam Power.

Generally, and with the exception of high, upland sources, which afford the force of gravitation, steam power is, as stated, the heart working the arteries as well as the veins of the system. The cost of the power may be exemplified in the instance of the British metropolis. Water is, in one instance, collected from springs forty miles distant; in another it is conveyed after filtration, through pipes, from sources more than twenty miles distant; and a constant supply, at high pressure, is given in each instance, that will carry thirty-two gallons per head to the tops of the highest apartments, for a rate of three-fourths of a farthing per head.

Now, even at that rate of charge,—which is the subject of contestation in Parliament as excessive,—it is so cheap as to make it dear and wasteful for the poorest housewife to go down from the top of any house to the bottom to pump water at the basement (even if the water were to be had gratis) and carry up sixteen pailfuls to the top. Indeed, if the supplies were delivered only at the basement, the cost of carrying them to the upper rooms would evidently exceed all the rates, i.e. the three-fourths of a farthing per head now paid for it, or even the full farthing per head, for which the companies are now in effect contending. Nevertheless, if the measure of the first General Board of Health had been carried, as I believe it will yet have to be, the service per diem would have been actually rendered for half a farthing per head in principle. Supposing the pitcher of a Rebecca to hold two gallons or 22 lbs. of water, a labour equivalent to that of sixteen of her journeys to a distant spring, would be rendered for half a farthing (by some millions of capital invested in machinery). To aid the conception of the economy of labour by this power, it may be stated that one hundred-horse Cornish engine working one hour per day would do the work of 50,000 Rebeccas.

Fire Extinction.

It is to be noted that a part of the service of the constant supply as proposed in our report on the supply of water to the metropolis, was for having hydrants, to which a hose might be attached, for a key to be given to the person who might in a minute or two attach a hose to it, and on perceiving a fire in any house, bring to bear upon it for its extinction jets equal in force to one or two horse-power. By the subsequent adoption at Liverpool, Manchester, and Glasgow of this measure then suggested, the large manual or steam-engine power, which has to be fetched from distances whilst the fire is raging, is dispensed with, except in some three per cent. of cases; and the losses of life and fire, and the insurance risks are reduced to one-third of those prevalent in the metropolis, whilst the expenses of the administration for the inferior result are reduced by one-half. Since this measure was proposed, electricity has been employed to speed information and relief. In the provincial cities, when a fire was getting ahead, and additional force of water by jets was needed, information had to be sent, by foot or horse messenger, to the distant pumping station, to put the engines at high pressure. But now the information is communicated instantaneously by the telegraph, and in a minute the force of the steam power at miles of distance will be felt on the spot where it is needed. By the unification of the works of the companies in the metropolis on a public footing, the force of the whole of fifteen thousand of horse-power may be made to converge from the extreme points of the metropolis to stay any threatened devastation by fire in any particular quarter where it may arise.

That the most important apparatus—the smaller apparatus for fire extinction, may be constantly ready without fail, it must, we considered, be kept in constant use, and it was proposed that it should be in constant use for street cleansing by the jet, which would cleanse completely and quickly at half the expense of the imperfect cleansing by the broom. Paris, Vienna, and Madrid even, are in advance of our metropolis, by the adoption of this mode of cleansing.

Present partial and fragmentary conceptions of the system commonly prevalent.

It will be found on examining the public discussions and proceedings in relation to the supply of water to the metropolis, that no general conception of any system, such as that hereinbefore propounded for its sanitation, has yet been attained. Fragments of it only are adopted, each very incompletely, and important parts are disregarded. The only part of the arterial and venous system which has gained a place in the common conception in the metropolis, is that of bringing the water to the doors of the houses in bulk under a responsible public authority. But what that authority shall be is imperfectly conceived or enunciated on political platforms. The comparative eligibility of different qualities of water for the supply of the metropolis, whether hard chalk water or such soft water supplies as those of Manchester and Glasgow, with infusions of peat during part of the year, are, as yet, unconsidered or disregarded by the representative authorities undertaking to deal with the subject. Nor is any account taken by them of the work of fire-prevention, as an addition to the service of the police force of ten thousand men, nor how the service of that force is to be combined or brought to bear in the metropolis as in provincial cities; nor what alteration of the service of cleansing sixteen hundred miles of street surface is required. Even on the preliminary questions of financial economy and the terms of purchase, there commonly prevails the greatest confusion of opinion, and that in the face of settled but utterly disregarded practice and principle. Moreover, no consideration has yet been taken of how, when the supplies of water are got to the door, they shall be got into the houses. Whilst mechanical, chemical, and engineering science have made the advance stated, their application is delayed for an advance of legislative science and administration for the protection of the health of the population. It is true that the political obstructions have not been confined to this country. The most serious obstruction to be apprehended is the intrusion into sanitary work of the element of political party spirit, which is more intent on showing the opposite party to have been wrong than of doing for the many what has been proved to be right. Impartial specialists are clearly of opinion that the politician has thrown back the progress of sanitary reform, including the principle of circulation, by a quarter of a century in this country. The like influences have been baleful abroad. From our Board we sent over to Paris to ascertain how the system of fixed fosses, with removal of their contents by cart, worked there. We found Paris stinking worse than London, and very heavily death-rated. The potent barrier to the introduction of the principle of circulation by water carriage was, in the view of the political officer, the interest of a large and troublesome body of men, the *porteurs d'eau*, who might raise an *émeute*—though it would be cheap to give them all retiring pensions. Besides these there stood in the way the large contractors for the *vidange*, the emptiers of the fixed fosses or the tanks in which such matter is detained in conditions of putrefaction, whom it would have been a large gain to the public to have paid off at the full profit of their contract.

The exposition of the arterial and venous system there was futile, and Paris yet stinks from the stagnation of putrefactive matter, though the sanitary officers are clear and hopeful about the adoption of the principle. A recent report to the State Board of Health at Boston indicates the obstruction to sanitary improvements from work in the cities being regarded as a reward for political services; and of course the more expensive the work, nay, usually the more ineffective, the greater the reward. Contract work is the most economical and eligible, 'if such work could be divorced from politics,' says the able assistant engineer in charge of improved sewerage for Boston; but as that may not be, 'day work' must be put up with. Sir Joseph Whitworth invented a very successful street-sweeping machine, which by the labour of one man and a boy did the work of twenty scavengers; and he conceived that in so enlightened a city as New York, that it was sure to be adopted. But there he was told at once that it would not work, because every machine would displace some eighteen voters. In London, being desirous of promoting the use of hydrants for street cleansing as well as fire prevention, I was ready to urge it, but I was myself warned in one influential district not to speak of the street-cleansing service, because the scavenging interest, which was preponderant at the Board, would probably oppose hydrants altogether.

In respect to the more immediate subject, the development of the system of circulation, it is to be stated that the practice has been in the larger provincial cities, as well as in the metropolis, to leave the work of carrying in the supplies from the mains at the door into the houses, and that of carrying away the fouled water and the excretory matter removable by water-carriage from the houses—to be done by uninformed tradesmen, plumbers and builders, without any qualification whatever, for a work which requires very special knowledge to execute it successfully. Those tradesmen persistently use lead-pipes, at a double and treble expense, to carry water, which sometimes acts powerfully on lead and seriously affects the health. Then it is conveyed into cisterns, often of lead instead of slate, or into common butts, where it stagnates, and imbibes the gases which make it dangerous to drink. Then they carry the overflow from these cisterns into the drains and sewers generally of deposit, evolving gases of putrefaction which ascend and contaminate the water in the cistern, more frequently with fatal results than are made known by any inquiries. The house services, which should be the capillaries of the system, are badly formed, without proper retaining arrangements, so that a constant supply becomes a source of constant pernicious waste. In London more than three-fifths of the water is pumped to waste. In the common conditions of the apparatus it is constant pernicious waste for a house. The house-drains (commonly) are made for a house of a size that would serve for a large street, and of permeable material, or loosely jointed, so as to detain beneath the foundation what it is intended to remove from it. Hence the sites and subsoils of towns become supersaturated, and the excrement sodden, and malaria is generated. Thus augmented supplies of the purest water are often made the sources of augmented disease. Thus it was shown in a recent inquiry before the Royal Commission into the sanitary condition of Dublin, that the introduction of a new supply of water of the finest quality at its source (except in winter time, when it has an infusion of peat unquestionably causing diarrhœa) was attended by a considerable augmentation of the death-rate, bringing it up to thirty-eight in a thousand, or double that of a healthy urban district. This was accounted for by the supersaturation of the subsoil by this additional water mixing with the matter detained in bad drains.

Prevalent Conditions of Stagnation in Towns.

In Liverpool a reduction of the waste of water is reported to have been attended by a reduction of damp in the lower houses, and by a marked reduction of the disease generated by damp, with an improvement in the death-rates. London has been water-closeted in a rudimentary way, but the work has been frustrated in great part by bad house-drains and badly constructed sewers. In respect to the construction of sewers, in my sanitary report of 1842 I described them and their connections as the bulb of a retort charged with putrefactive matter, and the house-drain as the neck of the retort, which carried the gaseous products of the putrefaction into the house. That condition still prevails through the greatest part of the metropolis. I would direct particular attention to the terms in which the chief engineer to the Local Government Board, occupying part of the new Government buildings at Whitehall, has described the sanitary condition of that head centre of sanitary administration. He said on a recent occasion: 'He had in his possession a report with regard to the sewers in Whitehall, Downing Street, Great George Street, and Victoria Street. He had felt obliged to make complaints of the closets connected with the new buildings in Whitehall, occupied by the Board of Health, and he declared that there was no new public building in Great Britain in a worse sanitary condition. It appeared from the return to which he had alluded that the sewers were flat-bottomed, flushing was never thought of, and that there was a deposit 15 to 18 inches deep in these sewers. The drains coming from the buildings had flap valves where they entered the sewer; these drains went direct into the buildings without any break, or other means of ventilation, to prevent the inflow of gas. The closet in the corridor leading to his office was occasionally so bad that he could not use it. Sometimes the wind entering from the drain would, he believed, have blown out a lighted candle, and the stench was horrible. Every drain had been tried upon that length of sewer all round Whitehall, and there was not a single instance where the inflow was not direct into the building. If such things were properly attended to the rates of mortality would be very different.' In the other parts of that great building there have been two fevers and two deaths ascribed to sewer poisoning. One officer described to me a disablement of nine months as due to it. A former Secretary of State for the Home Department stated that after long sitting in his office he felt low headaches, symptomatic of air contamination, and he was led to do as much work as he could at home. A former Premier was advised by his physician not to reside in Downing Street, and certainly its condition is detrimental to the official working force there. I can undertake to say of the lower apartments, occupied by the most industrious workers, that if they were lived and slept in, and were crowded as the common dwellings are, the seat of the Government of the Empire would be a fever nest.

The condition of that spot is pregnant with instruction as to the state of information on sanitary legislation and administration there, which is impotent for action, either for the relief of itself or of the general population by self-cleansing drains and self-cleansing sewers.

One attendant on all these defective constructions is their excessive expense, especially as respects the house drainage and sewerage works on the principle of stagnation: for it may be shown that on correct principles three houses and three towns may be well drained, at the cost hitherto incurred for draining one on the principle of stagnation.

The Tub System.

In the widely prevalent ignorance of any other conditions than those of stagnation in house-drains and sewers, the eruption of noxious gases from them is regarded as a constant, and a reaction has been occasioned for the application of the tub system for collection and removal in turns. In rural districts, and for detached cottages away from any system of proper drainage work, I have myself recommended the use of a pail with water under a seat, and the daily removal and application of the liquefied manure for garden culture on land trenched and prepared to receive it there, instead of bringing prepared soil to receive it in the house. The rude tub system of carrying excreta from the house to the land partakes of the expensive converse of the pail system of collecting water from the land, or the distant well to the house. Only consider the labour of sending earth to hundreds of thousands, or in the instance of the metropolis, half a million of houses, and bringing it away *daily*, as would be required by cleanliness and security from disease. In consequence of the excessive expense of carriage on the tub system, the removal of the solid excreta, where it is practised, is only effected at long intervals. At Paris it is retained in fixed fosses, which are emptied about twice a year, by a most offensive process, despite engagements to deodorise the matter. It is little better with all the movable fosses. At Manchester and other cities in England the receptacles were formerly only emptied once a year, and great injury to health was occasioned by the emanations of putridity. It was doubtless an improvement to provide a tub system, at the public expense (which would save the house owners the expense of outlays for a water carriage system), and remove the excreta weekly. But this weekly removal is still attended with pernicious results, for putrefactive decomposition begins in three or four days, often in some weathers in two days, or less, for which reason during the cholera and other epidemic periods we ordered that all excretive, indeed, all animal and vegetable matter, including the dust heaps, should be removed daily. But with a proper water apparatus the removal is effected instantaneously, and at many times less cost. Persons who have only been aware of the conditions of the bad organism which I have described — conditions of malformation and consequent diseased action of congested house-drains and congested sewers with deleterious effusions, and who know of no other conditions, may be told that in the healthiest sanitaria in the country, where epidemic disease is now entirely banished—namely, well-constructed and well-managed prisons, there is a soil pan in every cell. Provincial experiences are now demonstrative of the conclusions—that on a complete circulating organisation the whole of the excreta of the metropolis, which now remain within it in putrefactive conditions for weeks, months, and sometimes more than a year,—that these conditions of stagnation may be cured completely by the removal of all putrefactive matter by water carriage from beneath the site within the day; that such a capital as Paris might be purified within half a day; and if correct principles are adhered to in its works, Berlin will shortly be purified in still less time.

Distributed Cost of the System of Circulation.

Prejudice against the system is frequently raised by immediate payment of the whole charge for the works being exacted, instead of being duly distributed over a number of years. The experiences to which I have referred of complete provincial works would give the charge of the chief parts of the system of circulation. First for the works and service, and for bringing the supplies of water to the door of the house, one penny per week;—next, for services and works for carrying the water into the house, and for carrying the fouled water out of the house, a penny halfpenny per week;—and for the service of carrying it away from the door of the house, another penny per week; or a halfpenny per diem per house for the whole work of the circulating system, up to the removal of the fouled water from the site of the town. Some of the towns have charged much more for the service of the water supply, and have derived a revenue from it, and jobbing and malversation might in some cases have raised the amounts paid by the ratepayers; but the above would be about the correct general charge to the whole of the population. Since the first works were executed, the cost of labour has been largely augmented, and the total cost ought now, as I am informed, to be doubled, or brought to full one penny per diem per house, or nearly to a farthing per head of the population per diem if the entire work were to be done *de novo.* For the accomplishment of the propositions which I have first enumerated, and completing the system of circulation, it will sometimes be necessary to organise the steam power for action from several centres.

Relief of Low-lying Land from Stagnation.

Under the Sanitary Commission for inquiring into the means of improving the health of the metropolis, we found much of the low-lying parts of it literally marsh land, and surcharged with moisture, much of it from the upland waste waters and sewage. In the east there was a considerable extent of marsh land, so called, whence attacks of ague were at times distributed amongst the populations of contiguous urban districts. For the relief of these districts I consulted the engineering experiences of the fen districts of Lincolnshire, and there we found that relief was given by steam power applied at different levels, at 'sumps,' to which the drains of each level were made to converge, and by these means the water level was kept down to the depth required for agriculture. In our report we stated that in Lincolnshire the expense of pumping away the surplus rain water averages 2*s.* 6*d.* per acre, including all expenses of working with engines not of the most recent and improved construction. Calculating, however, that the expense of pumping the soil or waste water, in addition to the rainfall in London, would occasion a cost even twelve times greater than is incurred in agricultural or fen districts, or 30*s.* per annum per acre covered with houses ; as there are in the lower districts of the metropolis about twenty houses to each acre, and as the operation would extend only over half the metropolitan area, it had been shown that 'the annual charge per house, spread over the whole area, that area including the upper districts which were affected by miasms from the lower districts, would be 9*d.* per house per annum; but in this instance, as shown in the whole investigation, the outlay and the rate would really lead to a great reduction of the existing charges.' Plans were prepared for the application of this principle, which has not, so far as I am aware, been applied to the relief of any district in England. But an examination of the works substituted for it in London, which there is not time to treat of at present, will show it to be the most eligible for future application. By the converging principle the most rapid falls may be obtained. The converging system, as applied for the relief of the fen districts, is by means of rude ditch drains, tubular drain pipes being originally unknown ; but now tubular drain may be made small, and artificial falls given, and the discharge in any direction accelerated according to requirements, and the circulation thus maintained within basins of land as well as from flats. This is the principle now adopted and in progress of application for the relief of Berlin, which has a very flat area. The sewerage there will, if the house-drainage be well completed, be discharged fresh into the sewers, and the sewage will be discharged in several directions in the best condition for agricultural production, on the land to which it is to be applied, from the 'sumps,' to which the drains carrying fresh undiluted sewage—converge. For detached houses, and villages and public institutions, a valuable improvement has been introduced by Mr. Rogers Field, called the 'flush tank.' This is a receptacle which collects dribbles of sewage, until it rises to a certain height in the tank, when it reaches a syphon mouth, and is discharged with increased force in a sweeping flush. For larger applications of the converging principle, Mr. Isaac Shone has invented a pneumatic apparatus as an ejector, which Colonel Jones, R.E., V.C., assures me is completely successful.

Applications of Unstagnated and Undecomposed Sewage.

By the relief of the land by horizontal spring collection, and the distribution of pure water, direct and well aërated, without any stagnation, into houses; and by the immediate removal of all the fouled water, with all putrescible matter removable in water, without stagnation and before the commencement of putrefaction, the entire systems of stagnation may be held to be superseded, and the system of arterial and venous circulation accomplished.

Completion of the System of Circulation by the Direct Application of the Sewage to the Land.

The obstructions that stand in the way of the completion of the system, by the application of the liquefied manure of towns to agricultural production, still remain to be noticed.

Persons who only know of sewerage by their experience of its emanations, under the common conditions of stagnation and putrefaction, very naturally object to its application in the vicinity of their residences, and would do so with much reason if those conditions were essential. Violent opposition is made to the discharge of sewers into rivers, on the score of pollution. Whilst sewage, however, in the common condition of putrefaction, kills fish, sewage in another condition, that is to say, in circulation—fresh, or before putrefaction—

feeds fish. But on the score of waste I object to its discharge into the rivers, or anywhere except on the land. People do not object to the cultivation of land, as market garden land, close to their dwellings, or to towns. Nevertheless, such culture and high farming are frequently conducted in a manner productive of noxious emanations that are injurious to health, and make the culture there a nuisance. This is done by heavy top dressings of what is called 'town manure,' in the solid form, in which condition it remains stagnating until it is disintegrated by decomposition (by which decomposition its fertilising power is diminished), and it is then carried down into the soil by the rain. The complete remedy of this evil is to liquefy the manure at once—to put it in solution, and apply it to the soil in doses proportioned to the soil's receptivity ;—in fact, to apply it as sewage, by which means one load of stable manure may be made to do the work of more than two. I was advised when I looked into the subject, that the waste of the farmyard manures and other manures, by the methods the farmers used, was in extensive districts equivalent to another rental. On the other hand, it was pointed out in our instructions that applications of plain water in excess, by the method of submersion, creating marsh surfaces and marsh miasma, were often conducive to the rot in sheep and ague in men ; and, of course, that the distribution of sewage in the like manner would be productive of still worse results. At the irrigations at Paris, as I am informed, this danger has been incurred through excessive submersion by the unskilfulness of the small farmers to whom the sewage has been given, and that sewage —not fresh sewage—of a bad quality, as nearly all there is.

The fact should be known that for sanitation it is a work of skill to avoid the supersaturation of the soil ;—for cultivation it is a work of skill to avoid supersaturation, and to adapt the supply of the liquid manure to the 'hygroscopicity' of the soil, and the periods of the growth of the plant for root, or for wood, or for leaf, or for fruit. For the avoidance of stagnation and waste, and the expense of storage tanks, it is a work of skill to place every day's supply from the town on one part of the land or another, whatever be the weather, in frost or snow. In frost this has been accomplished at Dantzig by distribution under the ice. The whole of sewage farming is an art foreign to the common agricultural practice, and is as yet confined to a high order of horticulturists, growers of prize fruit, to whom its application on a large scale should be confided. Nevertheless, in some hundred of sewage farms, now conducted throughout the country by all sorts of rudimentary methods, with bad sewage from ill-drained towns as well as good, and by various rudimentary workings, the superior productive power of the liquefied manure has been established, not only in the bulk, but in the quality of the produce; and as to the bulk, whilst the average yield of agriculture in England may be taken to be as one, and the market-gardening as about three and a half, the sewage-farm produce has been as five. It is found that, as a rule, the sewage of more than a hundred of population may be utilised in an acre. As to the sanitary effect of sewage farming, the judges of the competition for prizes issued by the Royal Agricultural Society, of which Mr. Baldwin Latham, Mr. Clare Sewell Read, and Mr. Thursfield were judges, made particular inquiries about the sanitary results upon those engaged in the work, and they display them in a table of the death-rates. They state that the rate of mortality on an average of the number of years which these farms have been in operation (ten) does not exceed more than three per thousand per annum; that is to say, on a population of 380 men living on or working on the farms, and 137 children. From the difference of working under insanitary conditions amidst stable-dung and farm-yard manures, which are attended with fevers amongst families, and the working amidst liquefied manures, I should have expected a marked difference, but not so great as this, which must be about fourfold.

One obstruction to the application of the liquefied manure of towns has been the supposition that it can only be applied, by gravitation, on land immediately contiguous to the town, for which, as a consequence, consents are either refused, or, it being considered as accommodation land, excessive monopoly prices are exacted. Now on the converging system, and by 'ejectors,' the sewage may be carried all round, uphill, or in any direction of demand, with the addition of the cost of lifting—a cost, *i.e.*, for 80,000 gallons 100 feet high of 1*s.* which is inconsiderable, if the sewage is in its proper concentrated condition, unencumbered by an excess of rain or storm water, which, on a correct system, ought not to be admitted. A competent administration will utilise the ground allotted to, or contiguous to, public institutions, such as union houses, prisons, and others, and develope models of liquefied manure cultivation.

On the difficulty which presented itself for the completion of the system of circulation by the disposal of town sewage by surface irrigation near towns, particularly in the condition of putridity, in which all sewage was then only to be met with, I was led to consider of subsoil or subterranean irrigation. I got several friends who had gardens to try it, and the trials were very promising. Sir Joseph Paxton promised to try it systematically. But it was tried independently and systematically on a large scale by M. Charpentier, a

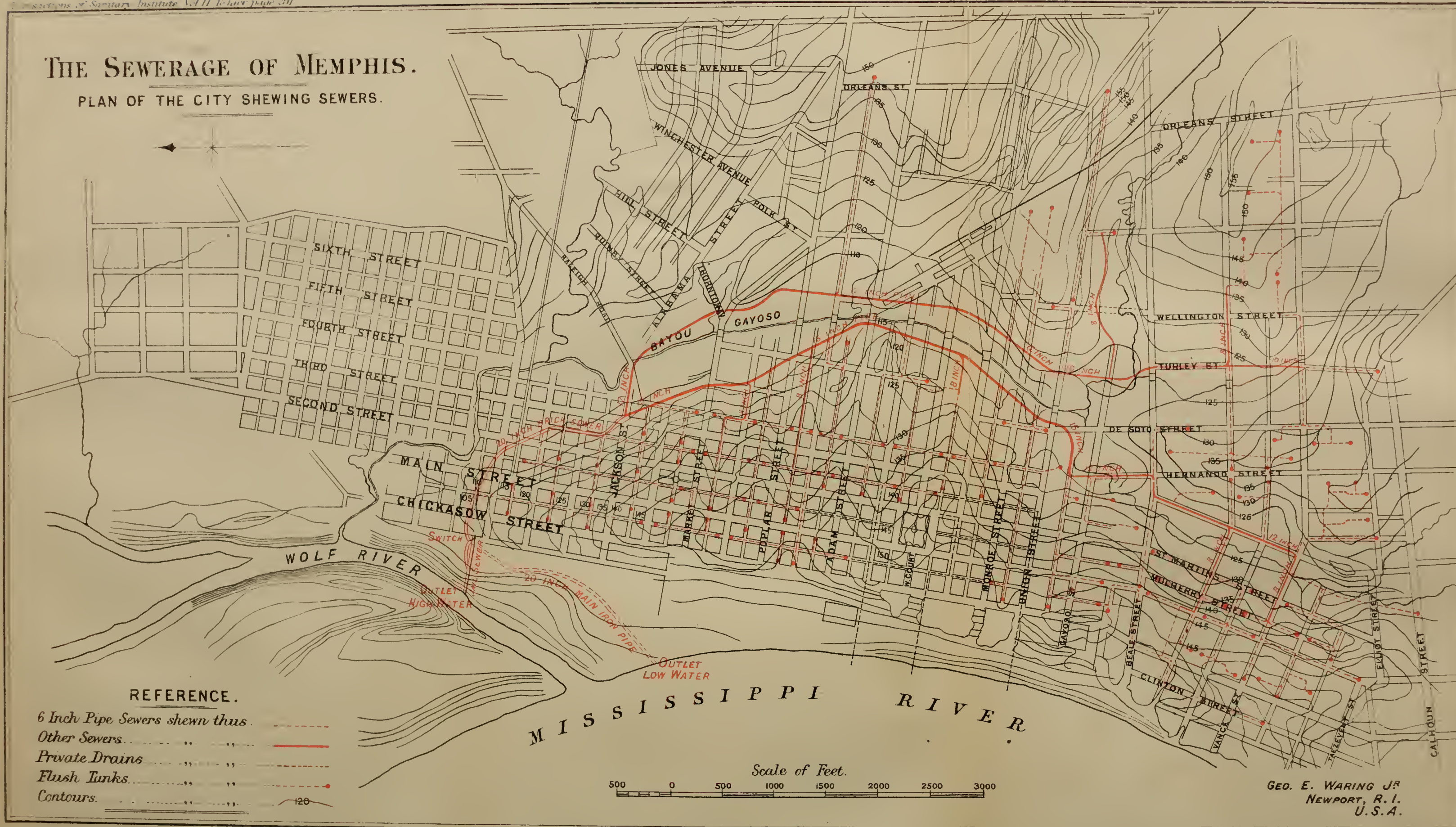
French vine grower, near Bordeaux, with whom I had correspondence on the subject. His trials were not with town sewage, but with liquefied manure; and certainly the results he obtained with vines and fruits, as well as with market garden produce, were most satisfactory. He contended for its superiority over surface irrigation, but it required great skill, and more capital than the ordinary surface irrigations. The early successes with surface distributions, however, withdrew my attention from it; but the method has been revived with success by Mr. Rogers Field in the disposal of the sewage of some villages; and his flushing tank greatly facilitates distribution by that subterranean method. It is also reported to have been carried out with success by Colonel Waring, of Newport, in America. I am confident that for high culture, for model gardens near towns, for deep-feeding plants and for fruit trees, for arboriculture generally and in hot climates, the method in skilful hands will be productive of very great results.

I would observe that about two-thirds of the general work of sanitation, in drainage works, is of earth-work on which, in the Continental States, soldiers may be well employed at extra pay.

In conclusion, if the subject be competently and impartially examined, the necessity for stagnation ('which nature abhors') is abolished. It is abolished in the collection and the distribution of water into towns; in the removal of the fouled water from houses and towns, and in its application to agricultural production; and the exposition of it by my deceased friend and ally as an arterial and venous system for the relief of urban populations, is fully justified by adequate experiences, for general application, by specialists. Indeed, it will be found on competent examination that the sanitary results of the complete arterial and venous system of circulation for towns are now so far assured by experiences as to warrant contracts being made for the reduction of common death-rates by one-fourth or by one-third. And with the addition of such collateral measures as Lord Shaftesbury's Act for the regulation of common lodging-houses, the ensuring of purer water supplies and good drainage, the prevention of overcrowding, and measures for the sanitary regulation of schools, and for physical training on the half school-time principle, a reduction of the common death-rate by one half may be made matter of contract. These things may under good administration be done, for all have been done. It should be our care to awaken public opinion so that it may insist that they shall be done.

EDWIN CHADWICK.

A LECTURE was given to the working classes of Exeter in the Victoria Hall on Saturday evening, October 25, 1880, by Dr. Bartlett, F.C.S. The Mayor presided, and there was a fair attendance of the working classes. The lecture was *extempore*, it was listened to with attention, and at its close a vote of thanks was unanimously presented to Dr. Bartlett.


THE SEWERAGE OF MEMPHIS.
PLAN OF THE CITY SHEWING SEWERS.
REFERENCE.
6 Inch Pipe Sewers shewn thus
Other Sewers ,, ,,
Private Drains ,, ,,
Flush Tanks ,, ,,
Contours ,, ,,
120
Scale of Feet.
500 0 500 1000 1500 2000 2500 3000
GEO. E. WARING JR
NEWPORT, R. I.
U.S.A.
MISSISSIPPI RIVER
WOLF RIVER
JONES AVENUE
ORLEANS ST
WINCHESTER AVENUE
HILL STREET
POLK ST
QUINCY STREET
RALEIGH ROAD
ALABAMA
THORNTON
BAYOU GAYOSO
SIXTH STREET
FIFTH STREET
FOURTH STREET
THIRD STREET
SECOND STREET
MAIN STREET
CHICKASAW STREET
JACKSON ST
MARKET ST
POPLAR STREET
ADAM ST
W. COURT
MONROE STREET
UNION STREET
GAYOSO ST
BEALE STREET
ORLEANS STREET
WELLINGTON STREET
TURLEY ST
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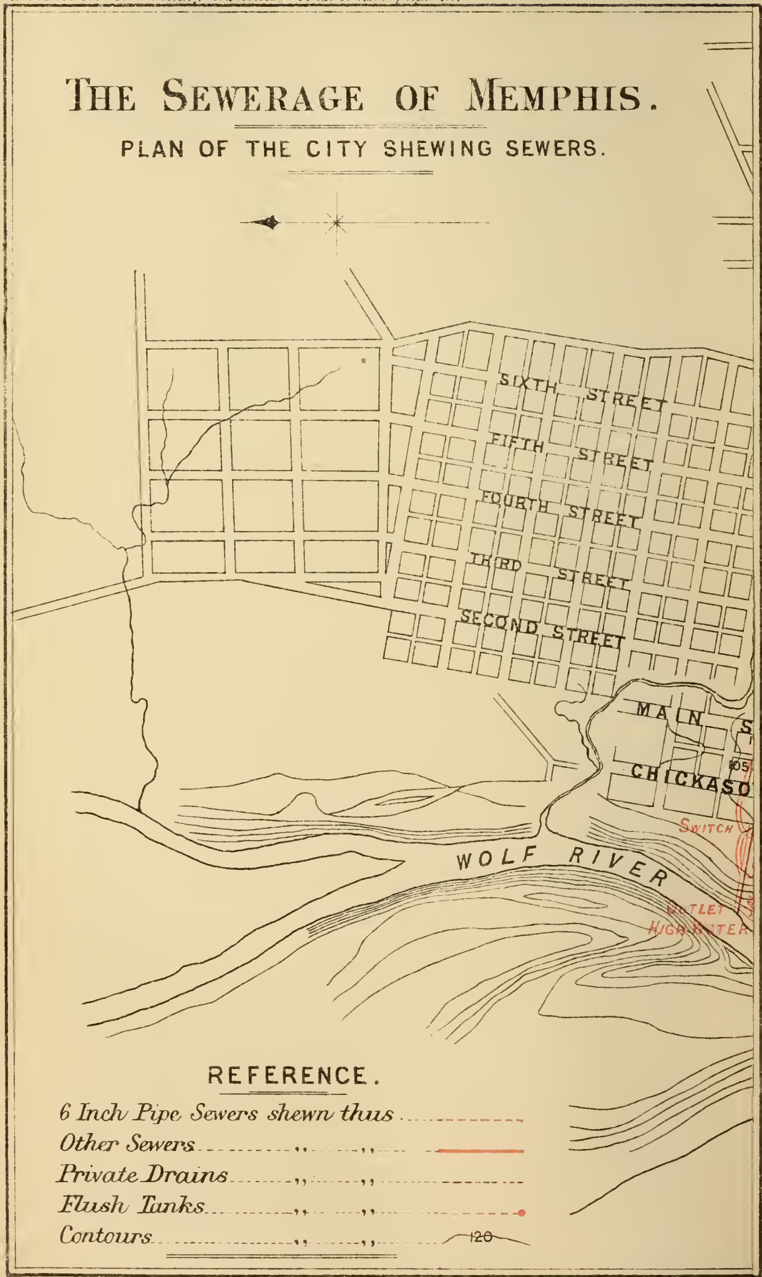
HERNANDO STREET
ST MARTINS STREET
MULBERRY STREET
CLINTON STREET
VANCE ST
TALEVENT ST
ELLIOT STREET
CALHOUN STREET
20 INCH MAIN IRON PIPE
20 INCH BRICK SEWER
SWITCH
OUTLET HIGH WATER
OUTLET LOW WATER
12 INCH
18 INCH
8 INCH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120

Paper on the Sewerage of Memphis (*Illustrated*).[1]

By Col. G. E. WARING, Junr., of Newport, R.I.

Memphis is a city of about 40,000 inhabitants, situated on the east bank of the Mississippi River, about midway between St. Louis and New Orleans. Its area, including its immediate occupied suburbs, is about four square miles. Of this about one square mile is the more strictly urban, being quite closely built over.—a considerable portion in compact blocks, and the remainder with semi-detached houses. Many streets of this part of the town were covered ten or twelve years ago with wood pavement, which, during the past four or five years, has fallen into very bad repair, and most of which is now being removed, its place being supplied by stone block pavement or macadam.

The accompanying map (Plate A) shows the conformation of the surface. The valley, beginning a little north of the northernmost portion of the main sewer, and occupied towards the south by the two branches of the main, is the lowest part of a gradual depression falling from the east and from the west. Through the bottom of this runs a deep cut called Bayou Gayoso. This bayou is the eroded channel of a stream ordinarily small, but, under occasional sudden showers, subject to an enormous increase of volume. Its sides are steep and irregular, and its depth is quite uniformly from 12 to 15 feet below the general level of its banks.

The Mississippi River has an extreme variation of level of about 35 feet. At least once during the year, and often two or three times, it fluctuates to the extent of from 20 to 25 feet. Extreme high water is reached, or nearly approached, almost yearly; but it is seldom that the subsidence goes to within several feet of extreme low water mark. At the highest stage of the Mississippi dead water sets back in the bayou for the distance of about one mile, or to Gayoso Street. From Market Street to the mouth of the bayou the left bank is quite flat for some distance back, so that at high water wide areas are overflowed, and in this part of the town many houses are built on piles. In places only the streets (artificially raised) are above the level of the flood.

The city was founded less than fifty years ago, and its growth (due to a most advantageous position in the heart of one of the best cotton-growing regions of the country, and on the great highway of western commerce), has been constantly interrupted by epidemics of various diseases, some of which have been so violent as to threaten the depopulation of the town. In 1878 there were over 5,000 deaths from yellow fever between August 14 and November 3, and on one single day the small heroic remainder of the Volunteer Relief Committee had 300 unburied bodies on their hands. Hope and heart seemed to have fled. When this epidemic was followed by another equally threatening in 1879, and when the voluntary and enforced exodus speedily reduced the population to one-third its normal amount it was seriously proposed, as the only means for protecting the whole

[1] This paper was omitted from the Engineering Section, in which it was read as the first paper on the list, because of a delay in the proofs.—Eds. T. S. I.

Mississippi valley against the serious menace to its prosperity, that a sufficient contribution should be raised to secure the control of Memphis, and that it should be blotted out of existence.

At this juncture a conference was held between the authorities of the city and officers of the National Board of Health, which resulted in the appointment of a Commission of physicians and experts to make a thorough survey of the situation, and to recommend measures of relief. I had the honour of serving as a member of that Commission, which sat in Memphis for a week in November 1879, and whose investigation was aided by a thorough house-to-house inspection of the entire city, and very careful chemical analysis of the water of the wells and cisterns, which constitute the chief source of supply, apart from the limited use of the very unsatisfactory water pumped up from a muddy river by a private company. These investigations disclosed an almost total absence of decent sanitary conditions. It is not worth while here to enter into details, nor is it to be understood that Memphis was worse in this respect than many other towns in the United States—North as well as South—nor worse, if we are to credit official reports, than many towns and villages in England. That it was seriously bad was fully demonstrated. The whole city, under as well as upon the surface, was reeking with organic filth. In another climate it would probably have escaped serious epidemics as successfully as other towns differently situated have done, but its condition, its situation, and its experiences made it evident that most radical measures of reformation must be adopted. The opinion of the Commission to this effect was accepted by every intelligent person in the city.

The situation at Memphis offered a rare opportunity for sanitary work. The absolute need of improvement was obvious, and the community had a full realisation of the fact that it was 'neck or nothing' with their city. The result has been that a community—overtaxed, plundered, and, indeed, driven by a former corrupt government to attempted repudiation—has accepted advice more radical, probably, than was ever seriously given before, has raised the money for the required work, and has put its house into more nearly perfect order than has any other town in the country. As an example, a year ago it had about 7,000 privy-vaults, many of which were from 40 to 60 feet deep (having been sunk to a porous stratum), and still more of which were full to overflowing. To-day hardly one of these vaults remains. Where shallow they were entirely emptied, and where deep their contents were removed to a depth of 20 feet from the surface of the ground, and all were filled with fresh clay. Every house was provided with a temporary earth-closet, and the contents of these have been *ad interim* removed by the health authorities. As fast as connections with public sewers have become possible, these earth-closets have been abandoned. The former custom of disposing of garbage, by shunting it into streets and alleys, has been entirely given up, and the most active and effective measures of surface cleanliness have been adopted. In short, apart from the work about to be described, which was only one element of the Commission's recommendations, much more has been done than would have been possible in a town less severely chastened by disease.

THE SEWERAGE SYSTEM.

In 1868, during the season of spasmodic prosperity which followed the close of the war, a careful survey of the city was made, and skilful engineers were employed for the preparation of a plan of sewers. This plan was the usual one of large storm-water sewers, varying in size from a 12-inch pipe to a 7-foot outlet main. The main sewers and the main branches, which alone were provided for in the plan, would probably have cost under present prices, 120,000*l.* The extension of the laterals to accommodate the whole city would have added very greatly to this. During the epidemic of 1879 this plan was revived, and estimates, varying from 200,000*l.* to 400,000*l.* were based upon it. It was evident to the Commission that such an expenditure would be found impracticable, and it became necessary to devise a cheaper plan for cleansing the town. I had had experience in the case of several small villages which indicated the feasibility of securing the desired result by the use of sewers of very small size, graduated to the single duty of removing household and manufacturing wastes. The suggestion had been formulated in a paper read at the meeting of the American Public Health Association at Nashville, shortly before the sitting of the Memphis Commission. It was determined to recommend this system as a substitute for the more costly one. The recommendation was accepted by the Citizens' Committee, and later by the government of the city.

The plan proposed was without precedent in the case of a large town, and the fear lest it should prove inadequate became a serious obstacle to its general acceptance. Those who were timid concerning novelties, and those who were interested in the supply of material for the larger works, were so effective in their opposition that it became necessary to repeat the arguments a second, and even a third time, before it was finally determined to undertake the work. This determination was reached about the middle of January, and ground was not broken until the 21st of that month. There was at that time no supply of material on the ground, no considerable force of labourers had been engaged, engineers had but just arrived, and preliminaries which might profitably have occupied several months had to be dispensed with. It was all-important to complete the sewerage of the thickly-settled part of the town by the end of May, the turning up of the soil in such a climate in hot weather being extremely hazardous, and in spite of the disadvantages and embarrassments, the sewerage of the closely-built part of the city was practically completed by June 1. By the middle of April many houses had already been connected with the sewers, and on June 1, when the work was stopped, about 1,200 connections had been made. The plumbers have been actively at work throughout the summer, and, while there are yet many houses depending on their earth closets, the use of the sewers has become sufficiently general to prove their entire adequacy for the work for which they were intended.

The system has recently been very carefully examined by a committee sent from New Orleans, to judge of its adaptability to the needs of that city. The chairman of the committee, in his preliminary report, speaks in the most favourable terms of the working of the system, and will recommend its adoption in New Orleans. The 'Memphis Avalanche' of July 23, in an editorial, says: 'The examination of the Memphis sewerage system yesterday, by the Taxing District authorities and the committee from New Orleans, resulted in convincing all parties that it was a great success. There is not a hitch anywhere, and no complaint has ever been heard of the slightest defect in the clockwork regularity with which all the parts of this vast net-work of underground pipes carry the sewage of the city to a given point, and deliver into the Mississippi River.' Every indication points to the possibility of the general adoption of this system as a substitute for storm-water sewers, hitherto universal in the United States.

It is proper here to recite the reasoning by which the recommendation of this system was influenced:—

1. There have been in the United States many instances in which small towns have employed engineers to prepare plans for sewerage, with the sole result of showing the cost of execution to be so great as to constitute an absolute embargo. While compactly built cities, each house having but a short frontage on the street, may well afford the cost of storm-water sewers, the execution of such work, where each proprietor has from one hundred to several hundred feet of front, would entail an expenditure so great as to constitute an insuperable objection to it. Practically the contemplated work is rarely if ever carried out under these circumstances—a community naturally prefers to continue the risk of danger from cesspools rather than to burden itself with such enormous indebtedness. One of the arguments by which the postponement of these costly works has been secured has been based on the very general offensiveness of the storm-water system, with its reeking inlet catch basins, and on the unavoidable production of sewer gas, arising from the decomposition of its unflushed contents.

2. An investigation into the history of the sewerage of many of the smaller cities disclosed the fact that in no single instance had the work been undertaken because of the injury or inconvenience resulting from the flow of storm-water over the surface of the streets. The desire to get rid of foul wastes was found to have been in every instance the controlling motive. The adoption of works large enough for the removal of surface water was simply a matter of tradition. No other system had been used, therefore no other was considered.

3. Assuming that the admission of storm-water to sewers might safely be neglected, to say nothing of its attendant disadvantages, the next question was to determine the pipe capacity needed for the removal of foul wastes only. There exist ample formulæ for the determination of this question, but the municipal mind often fails to appreciate the full force of scientific theory, and it naturally hesitates to try costly experiments. The only way to secure conviction in this matter was by actual physical demonstration. I had, fortunately, early in 1879, procured authority and a sufficient appropriation from the National Board of Health to make actual gaugings of the dry weather

flow of public sewers in different parts of the country. The results of these gaugings were the surest foundation of the Memphis recommendation. They may be briefly summarised as follows :—

A sewer in Madison Avenue, New York, with a length including its branches of about 7,000 feet, the district being about one-half built up with houses of good class, carried at the time of its greatest dry weather flow a stream 3·5 inches deep through a notch (in a weir) 4 inches wide.

A sewer in Providence, 1,391 feet long, draining forty-one houses with a population of 267, at its greatest flow filled a 6-inch pipe $\frac{7}{8}$ inch deep.

A sewer in Burlington, Vt., 2,790 feet long, draining fifty-four houses with a population of 325 persons, showed at its greatest flow a depth of 1·2 inches in a 6-inch pipe.

A sewer in Milwaukee, draining an area of 70 acres, containing 500 houses and a population of 3,035 persons, at its greatest flow filled a 6-inch pipe 5·5 inches deep.[1]

The outlet sewer of the Hudson River State Hospital at Poughkeepsie, N.Y., where the use of water is equal to that of an urban population of 2,000, had its greatest flow carried through a 6-inch sewer with a depth of 3·25 inches.

A characteristic street sewer in Poughkeepsie, removing the wastes of a population of 426, at the time of its greatest flow filled a 6-inch pipe to a depth of 2·25 inches.

The State Lunatic Hospital at Taunton, Mass., with 659 inmates and a most abundant water supply, has two separate outlets, one for general use and one for the laundry only. The greatest flow of the former reached a depth in a 6-inch pipe of 1·75 inches; and the laundry flow attained, through a pipe of the same size, when its ten large washing machines were emptied simultaneously, a depth of 2·25 inches. The flow from both drains, supposing the maximum of each to be concurrent, would have been carried through a pipe 4·58 inches in diameter if flowing at the average velocity of the two. It is suggestive that it had been seriously proposed that the State of Massachusetts should pay one-half the cost of a 5-foot sewer more than a mile long because of its contributing to the city of Taunton this small stream of sewage, which would be amply accommodated by a 6-inch pipe.

The most striking result of these gaugings was that developed in the city of St. Louis, where a sewer 7·25 feet in diameter (necessarily large because of the occasional need for carrying off ponded surface water) drained an area containing 1,370 houses occupied by a population of 8,200. This sewer had its greatest flow carried through a

[1] Incidentally the gaugings of this sewer are otherwise instructive. The diameter of the main is 42 inches. It was reduced in the course of the experiment to 10 inches, to 8 inches, and to 6 inches.

The influence on the velocity of the stream by increasing its hydraulic mean depth is illustrated by the following figures:

42-inch sewer, 6 inches deep; cross-section of stream, 121·3 square inches.
10-inch sewer, 4·5 inches deep; cross-section of stream, 33·1 square inches.
8-inch sewer, 4·5 inches deep; cross section of stream, 27·7 square inches.
6-inch sewer, 5·5 inches deep; cross-section of stream, 27·14 square inches.

12-inch pipe, which was filled to a depth of less than 7 inches. A calculation of the actual discharge of this pipe showed that the sewer must have received a very large amount of ground-water, and that the public supply must have been most wastefully used, for the discharge was over 1,000,000 gallons per day, or more than 130 gallons for each member of the population; that is, the flow was as great as it should be with a population of over 30,000 using only an abundant amount of water.

There is a satisfactory reason for not accepting the exact teachings of these gaugings in regulating the sizes of sewers, viz. that no sewer should be used of a smaller diameter than 6 inches, (*a*) because it will not be safe to adopt a smaller size than 4-inch for house drains, and the sewer must be large enough surely to remove whatever may be delivered by these; (*b*) because a smaller pipe than 6-inch would be less readily ventilated than is desirable; (*c*) and because it is not necessary to adopt a smaller radius than 3 inches to secure a cleansing of the channel by reasonably copious flushing.

On the other hand, it may be assumed that no sewer should be more than 6 inches in diameter until it and its branches have accumulated a sufficient flow at the hour of greatest use to fill this size half full, because the use of a larger size would be wasteful, and because when a sufficient ventilating capacity is secured, as it is in the use of a 6-inch pipe, the ventilation becomes less complete as the size increases, leaving a larger volume of contained air to be moved by friction of the current or by extraneous influences, or to be acted upon by changes of temperature and of volume of flow within the sewer. The size should be increased gradually, and only so rapidly as is made necessary by the filling of the sewer more than half full at the hour of greatest flow.

In making the recommendation for the adoption of this small pipe system for Memphis, no account was made of the fact, which is believed to be of serious importance, that all sewers large enough for the removal of surface-water, unless they are provided with a copious daily flush, are sure to be objectionable, especially in our hot summer climates, and during our very long summer and autumnal droughts. While this argument is believed to have great force, it was thought best not to antagonise the influential advocates of the large sewer systems.

THE MEMPHIS WORK.

It will be seen by reference to the map (Plate A) that the grades in Memphis are quite generally very good; so much so that it was considered safe, even in the most thickly settled parts of the city, to continue to use sewers of a diameter of 6 inches for a length of 3,000 feet (including the lateral branches). There were therefore very few cases where it was necessary to make lateral sewers of a larger size, though in a few instances they were increased to 8 inches. The two separate systems whose mains come together at Jackson Street begin at that point with a 15-inch pipe for the west side of the bayou (or river side), and a 12-inch pipe for the east side. The 15-inch main on the west side is continued as far as the junction of Hernando and Beale Streets; from this point there is a 12-inch pipe as far as Vance Street. All tributaries are either 8 inches or 6 inches in diameter. On the east side the 12-inch main goes as far as Union Street, whence its extension to Vance Street, with a view to future work towards the south, is of 10-inch pipe. The rest of this system is of 8 and 6-inch pipes.

From the point where the two mains come together at Jackson Street, the outlet is by a 20-inch brick sewer reaching now as far as the 'switch' near Wolf River, whence it is continued with 20-inch pipe to a junction with the 3-foot iron pipe from the Jail, discharging into Wolf River below low water mark. This outlet is to be used, after the work is completed, only during high stages of the river. The low water main, which will be of brick to about the extension of Jackson Street, will be continued thence by a 20-inch iron pipe with leaded joints to below low water of the Mississippi near the foot of Market Street. During high water stages of the river, this extension of the main will be filled with dead water quite back to the switch, and it was feared that to discharge the foul outflow by this course would lead to the formation of serious deposits. Through the much shorter line by the jail pipe there would be less danger of difficulty from this source.

The switch by which the flow is diverted is not absolutely water-tight at either of its ends, but it serves perfectly for the diversion of all solid matters.

Concerning the construction of the work, there is not very much to be said which can interest an association of sanitary engineers. A few details are shown in the accompanying Plate B.

The object aimed at is simply to secure the complete and speedy removal of all foul sewage through pipes absolutely tight as to their joints; true as to grades, and laid on generous curves; to secure the most complete ventilation possible; to cause the least possible disturbance of the flow at the numerous inlets; and to give every pipe an effective daily flushing.

To prevent the adherence of solid matters at any point in the sewer, gaskets are used at all joints to prevent the intrusion of cement. These gaskets have the further effect of allowing the sections of pipe to be held in place until two or three lengths are secured, so that when the cement is once applied it need not be disturbed by the movement incident to the laying of new sections. In order to secure a concentric bore at the joints an 'adjuster' was used in the case of the smaller pipes. Its construction is shown in Plate B. It is simply a device by which, on tightening a screw, three buffers of india-rubber are brought to a firm bearing on both pipes, lapping the joints. When a new section is laid in place, the adjuster is put in position and tightened, holding the pipes concentric until the gasket is tightly pressed into place. It is then withdrawn and used for the making of a second joint, the previous gasket taking up any movement and allowing the cement two or three joints to the rear to remain undisturbed until it sets. This method has been found to work well in the hands of ordinary pipe-layers.

Although the natural soil of the site of Memphis is usually favourable, there were many places where artificial grading, and where the former use of the various depressions as a 'dumping ground,' had made an almost impossible foundation for the work. The difficulty in such cases was overcome by the use of 'saddle piles' made of 1-inch boards wider than the outside diameter of the pipe, and sawed to the proper radius. These piles were made longer or shorter according to the depth of the soft material, and were then driven exactly to grade, two piles being placed under each 2-foot section of pipe. This was found to be much better than the use of gravel or planking, making it easy to secure the exact grade at each point, and not subject to disturbance by the feet of the workmen. By excavating the bottom to a line a few inches below grade, the cement of the joint is allowed to set without contact with the water of the trench.

A new form of house connection or branch piece was adopted. This is shown on Plate B in two sections and in perspective. The house branches in all cases, even for the largest establishments, were restricted by law to a diameter of 4 inches. The extension of size from the diameter of the branch to the diameter of the main is made by a funnel-shaped branch piece delivering its flow at the very bottom of the main channel and, at the same time, furnishing ventilation to its very crown. This is a slight modification of the device in general use, but it seems to me to possess decided advantages.

By an ordinance which is strictly enforced, the furnishing of an unobstructed ventilator, 4 inches in diameter, reaching to the top of the house, is compulsory in every case. Connection with the sewer is also compulsory in the case of every building occupied for any purpose at any time during the day. In all probability these frequent ventilators, at various elevations, and variously exposed to different winds, would suffice for the complete ventilation of the whole sewer system.[1] To provide against any possible defect in this regard, as well as to afford an opportunity for inspecting the flow, there is placed at the lower end of each lateral, near its junction with the main sewer, a 'Fresh Air Inlet,' the construction of which is shown on Plate B. This furnishes a free access for air through an open grating at the surface of the street—following the course of the arrows to a T branch at the top of the sewer. The entrance of dirt and rubbish is prevented by a cast-iron plate shown in position at A. To facilitate the removal of accumulated dirt it is dropped to the position shown by the dotted lines B; and for the inspection of the sewer it is set back to the position C.

The most striking departure from ordinary custom and prescription is the entire absence of man-holes and lamp-holes, and the utter disregard of the alignment of the sewer, so far as the question of examination or cleansing is concerned. We trust to the open inlets for ventilation and to daily or half-daily flushing for cleansing. Should a sewer at any time become obstructed, the obstruction would manifest itself at the lowest house connection above the point of

[1] When the sewerage is completed there will be about 7,000 of these 4-inch ventilating pipes for the 40 miles of sewers of the city, being an average of one ventilator for every 30 feet of sewer, besides the air inlets at every lateral.

THE SEWERAGE OF MEMPHIS.

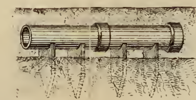
DETAILS.

ADJUSTER.

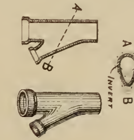
SECTION.
For holding pipes Concentric.

CROSS SECTION
Showing Indian Rubber bearings M N O.

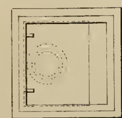
SADDLE PILES.



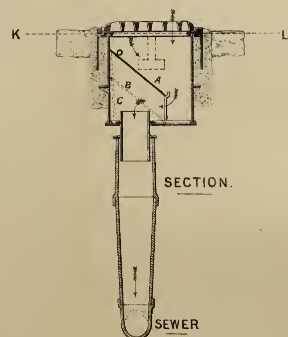
HOUSE CONNECTION DRAIN.



FRESH AIR INLET

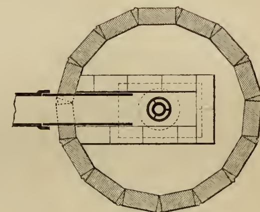


PLAN AT K.L.



SECTION.

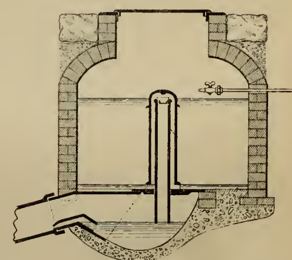
SEWER



PLAN.

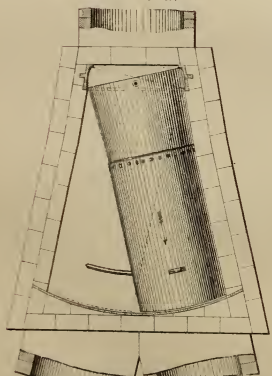
FIELDS FLUSH TANK.

SECTION.



SWITCH

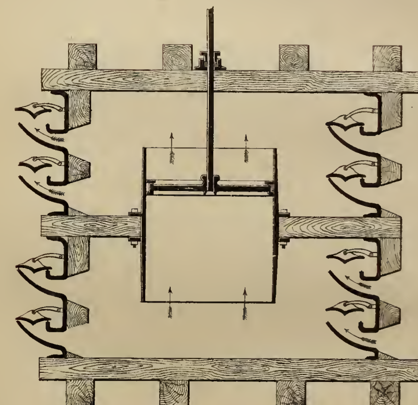
MAIN SEWER



HIGH WATER MAIN

LOW WATER MAIN

FIJNJE PUMP



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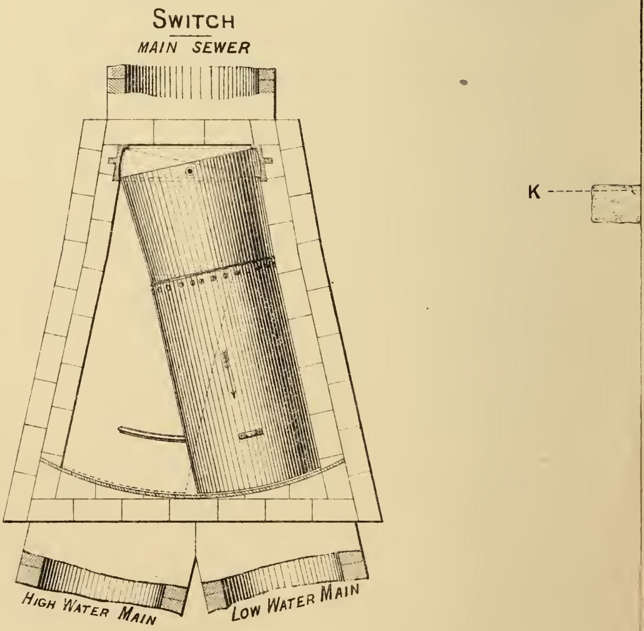
GEO. E. WARING J^R
NEWPORT R.I.
U.S.A.

THE SEWERAGE OF MEMPHIS.

DETAILS.



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stoppage, and the stoppage would have to be removed by digging down and opening the sewer itself. This would, of course, cost more than to withdraw the obstructing substance at a man-hole; but no single instance of stoppage has yet occurred, and I am confident that the interest on the cost of man-holes and lamp-holes would be enormously greater than that of the occasional openings that may become necessary.

In fact, it is difficult to understand why these sewers should become obstructed at all. They have no projections or rough points to collect foreign substances; nothing can get into them except through pipes of materially smaller diameter than their own; and each sewer, with its branches, is swept from end to end at least daily, by a large volume of water, rapidly discharged from a Field's flush-tank. There are now about 120 of these flush-tanks in constant operation, and when the work is completed the number will be increased to over 150. Observations taken at the fresh-air inlets, at the time of discharge, show the current from the flush-tanks to be of such velocity and depth as to ensure the complete removal of any object which we can conceive to gain admission to the sewers.

It is certainly not necessary in describing this work to English sanitarians to enter into any long account of the flush-tank of Mr. Rogers Field. The particular arrangement of the apparatus employed at Memphis is shown in Plate B. The discharging capacity of each tank is over 100 gallons. The diameter of the discharging limb of the siphon is $3\frac{1}{2}$ inches, and the discharge occupies from thirty-five to forty seconds. It was found advantageous to make the outlet chamber and the subsidiary siphon—employed to unseal the large siphon—in one casting of iron. This casting includes a bearing for the iron plate upon which the flange of the siphon rests, thus obviating the danger of improper adjustment when the setting of the different parts is left to the eye and judgment of the builder. The theory upon which the flushing appliances have been arranged is that in a sewer of such small size as 6 inches, with frequent house connections, there is no danger of an accumulation of organic matter except toward the upper end of the sewer, where the constant flow is too slight to carry forward the heavier matters introduced through the house drains; that, after the discharge from a certain number of houses shall have been added to the current, everything is sure to be carried forward by the natural flow, so that all that we need to secure, so far as the prevention of deposits and stoppages is concerned, is the flushing of the first few hundred feet of each line. That 100 gallons of water discharged in forty seconds into the head of a 6-inch sewer, will effect this object, is not questionable. The effect of the increased flow through the lower part of the lateral sewer, and of the accumulation of the discharges of a number of flush tanks in the sub-mains and mains has, as a matter of course, a beneficial effect, by increasing their scour.

The ability of these sewers to keep themselves clean, and therefore to keep themselves free from sewer-gas, has been more severely tested, during the earlier months of their use, than it will be after all the houses of the city shall have been connected with them. The distance from the head of the sewer to which it is necessary that the effect of the tank flushing should reach, of course decreases as additional houses are connected, and it is, I believe, amply proven by three or four months of entirely successful use that these sewers will continue for all time to be entirely satisfactory in this respect so long as their flush-tanks are kept effective. The results of the gaugings of the dry-weather flow of a number of sewers, previously recited, show that the system, as established, will be effective for a population of 60,000. It is not, therefore, too much to say that the success of the Memphis sewerage is demonstrated. It is not, of course, to be hoped that there will be an entire immunity from stoppages, but there is every reason to hope that these will be so few, and so easily removed, that the wisdom of having avoided the expense of making man-holes and lamp-holes will be established by experience.

As Memphis, like nearly all of our southern cities, is, except in its business portion, without cellars—very many houses of a good class being built on piers, with a free circulation of air under the main floor,—the sewers have been laid almost uniformly at a depth of 6 feet.

In order to avoid the risk of danger from the careless making of connections, and to facilitate and cheapen the work of house connection, a 4-inch branch has been carried from the junction piece of the sewer to the outer line of each house lot. This branch is constructed as the work on the public sewer progresses, and its upper end is immediately closed with an earthenware cap, fastened in place with clean mortar.

The ordinance concerning private works requires that the 4-inch drain of iron or earthenware shall be extended from the foot of the soil-pipe to within one length of its junction with the branch from the sewer. It must communicate directly with the soil-pipe without the intervention of a trap or contraction of any sort, and the soil-pipe must extend above the roof of the house with the full diameter of 4 inches, and open at the top.

Every slop-stone, water-closet, sink, or other vessel within or without the house must have its own independent trap. Apparatus of all kinds must comply with certain restrictions, and all is subjected to official inspection before acceptance. Neither the 'pan'-closet, nor the 'Brahma'-closet, nor any other of their class, is allowed. The use of 'hopper'-closets is encouraged. All of the plumbing work of the establishment must be accepted by the inspecting engineer before the final connection with the sewer is permitted, and this final connection must in all cases be made under his immediate supervision.

In anticipation of the large amount of work to be done, the plumbers had laid in large stocks of pan-closets, and there was some opposition to the prohibition of their use; but a friendly conference with these mechanics, and an explanation of the object of the regulation was frankly accepted, all prohibited apparatus being returned to the manufacturers. The ordinance prohibits the use of any closet which has an unventilated space between two water-seals of more than 100 cubic inches capacity, or which has an unventilated space of any size within which any part of the mechanism moves.

It is thus made impossible for foul matters to lodge in any part of the house drainage or sewerage system except in the running traps of the different vessels, one side of the trap being exposed to the open air and the other side to the well-ventilated atmosphere of the drainage system. The requirements concerning the flushing of closets, &c., are such as to secure the most complete practicable removal of whatever they may receive.

SUBSOIL DRAINAGE.

One of the marked benefits arising from the construction of ordinary systems of sewerage results from the greater or less porosity of the works, which affords a means of escape for subsoil water—which, in other words, drains the ground. This benefit is accompanied by the marked disadvantage, that during dry seasons the liquid sewage, which is needed to carry forward the solid parts, and which is saturated with filth, leaks out into the soil, leaving the solid matters stranded in the sewer, and polluting the ground. In the work at Memphis this leakage is obviated by the absolute tightness of the jointing of the sewers. The draining of the soil is effected by the use of ordinary agricultural drain-tiles laid beside the sewer in the same trench. The effect of this part of the work has been so great as to have had a marked influence on the dryness of both soil and atmosphere, producing, as is believed by the sanitary authorities, a decided reduction of malaria and a modification of the prevailing local tendency to rheumatism and pulmonary irritation.

The subsoil drains do not deliver into the sewers, but find their outlet directly into the bayou and its branches. In more level ground it may frequently be necessary to discharge the tiles sooner or later into the sewer system. This should be done with precautions against the back-flow of sewage into the tiles.

THE BACKWATER OF THE MISSISSIPPI.

The improvement thus far described relates only to the high-lying parts of the city, and to a portion of the lower area only during low stages of the river. The exclusion of back water from the bayou is to be undertaken in the autumn. A dam will be built at the crossing of Second Street with a 3-foot brick conduit below the level of the bottom of the stream. The upper end of this conduit will be furnished with a Fijnje pump,[1] the principle of the construction of which is shown in the accompanying plans. This pump has been in successful use in Holland during the past thirty years, and its employment in the United States has been sufficient to show its entire efficiency. It seems admirably adapted for the case under consideration, inas-

[1] This pump is named after the inventor.

much as it will afford a perfectly free outlet for the flow of the bayou during low stages of the Mississippi, and will serve as an efficient valve-gate or back-flow preventer as the river rises. Its piston will be driven by a vertical cylinder directly above it, and as the river rises it will be able to discharge all ordinary flow with ease.

At times, even when the river is low, the immense volume poured into the bayou by copious thunder storms will be far beyond the capacity of the low-level outlet, and even during the season of high water there may be occasional storms which will exceed the capacity of this channel. To provide for this temporary flood the upper 6 feet of the dam are to be constructed with swinging valve-gates. All storms of the locality which cause such floods are of very short duration, so that the discharging capacity of the pump, or during low water, of the unaided low outlet, will be sufficient to discharge the stream, except during an hour or two of its greatest flow. And as soon as the excessive flood shall have passed, the accumulation will be removed by the pump within twelve, or at the utmost twenty-four hours.

For the completion of this part of the work a separate system of sewers of small extent will be constructed for the area lying between the 20-inch main and the bayou; its outlet discharging directly in front of the entrance to the pump. During low water this sewage will pass out with the natural flow of the bayou, and at high water it will be carried by the suction of the pump.

SANITARY EFFECT.

It would be premature to express an opinion as to the full effect of the work described on the sanitary condition of Memphis. Its epidemics of yellow fever and its excessive mortality from consumption, malarial diseases, and rheumatism have perhaps been due not entirely to the presence of filth and of soil moisture. All that it is safe to say is, that so far as they have been produced by these influences, it is fair to suppose that the sewerage and drainage will obviate them. The authorities of the city are already ascribing their present unprecedented low death rate and almost entire immunity from malarial diseases to the execution of these works. It will certainly be very gratifying if the experience of future years justifies their belief. Whether their belief shall be justified or not, I think it is already demonstrated that the methods adopted are effective in securing their immediate physical aims. I have described them thus minutely, at the request of a member of the Council of the Sanitary Institute, partly as a matter of information concerning an important American work, and partly to indicate the degree to which Mr. Rawlinson's original recommendations in favour of the use of small pipe sewers has been accepted by his Transatlantic followers.

GEO. E. WARING, JUNR., Newport, R.I.
Engineer of the Work.

The President said that they were much obliged for the paper sent by Colonel Waring. Sanitary works, if they were to extend, must be cheap. He must say that he thought the author of the paper had been acquainted with reports written in 1843 by Mr. Chadwick, in which the separate principle was advocated, and sewers of small diameter recommended. In 1849 Alnwick was drained on this principle, and no one had complained of the drains. After 1848 this mode of drainage was taken up and discussed by the opponents of the system with great virulence. He must confess that he never trembled in the presence of man in his life until he stood up at the Institution of Civil Engineers, knowing that he was alone to face the persecution against the small drains and small sewers proposed by Mr. Chadwick, a system which left the rainfall to be carried off on the surface From that meeting a resolution went forth which led to the adoption of the large sewers like those in Paris, Brussels, and other cities. But Paris and Brussels, with all their large sewers, were not sewered cities, but had the smells of cesspools, owing to the generation of gases in the vast space of these great sewers. In this plan of Memphis different principles were brought to bear. The engineer knew that he could not deal with the tropical rains that fell. If an engineer went into a city and made a rule-of-three sum as to what should be done to take away the rainfall, he made an egregious mistake. The surface water should not go into the sewers, but flow over the surface. There was one thing in the plans that he did not agree with, and that was the absence of man-holes. He thought it would be found that there must be man-holes, as there would be sure to be chokages at some time, and with man-holes there would be no necessity to break up the road to find the spot. He was a member of the Army Sanitary Committee, and, as they knew, great works were contemplated in India, and the chief thing he had to compete with there was the desire of engineers to make enormous sewers to meet the rainfall. The rainfall in India at times was 30 inches in twenty-four hours, and how was an engineer to provide for that? If he made railway tunnels for drains he could not get the rainfall in, while in dry weather the tunnel would be filled with foul air, and thus be a source of evil to the city. The rainfall must be allowed to flow over the surface. If this caused injury to the surface they must adopt means to repair the injury, but they should not make enormous sewers which, in dry seasons, would be areas for creating the very evils they were intended to cure. He had not succeeded in getting his advice followed in some large towns, but in Bombay they had decided to keep out the tropical rains from the drains and provide surface drains, leaving the sewers for sewerage alone, and he, therefore, hoped soon to see Bombay an example to other cities. They were told by one of our present great engineers that sewers should be large enough for men to get into to clean them out. Well, all he could say was, that the Legislature had passed a law to prevent boys going up chimneys, and he hoped a law would be passed to prevent men from going into sewers to clean them out. He, for one, would not have the blood of men who were killed in this work upon him. He mentioned instances of places sewered on the principle laid down in the paper with marked success. He moved a vote of thanks to Colonel Waring.

Mr. Chadwick seconded the motion. Colonel Waring had just been consulted on the sewerage of Washington on the same principle as Memphis. If that was undertaken it would be a lesson for the Metropolis of Great Britain and other large cities both here and in Europe.

Dr. Richardson asked the Section to consider whether it was not possible to correct the error in the Metropolitan Main Drainage Works, of mixing the sewage and storm water, by running sewerage pipes through the existing large sewers? If so, it would be a great advantage, by which the mistakes of the past could be corrected.

The President replied that when new sewerage plans were laid before his Department they always came before him. He asked if there were existing drains, and if so, he then advised that the old drains should be reserved for the water and the new drains for the sewage.

Dr. Richardson asked whether such a plan as that which he had just suggested could not be adopted in the immense sewers of London.

The President said that London was sewered, and all the eloquence of an archangel would not avail to effect an improvement. Belgravia, the most fashionable part of London, notwithstanding the great expenditure on it, was subject to flooding in the basements from the sewers, and was the foulest part of all London. The sewers contained deposits, and were charged with sewer-gas. In the Government buildings, in Whitehall, when people came to reply to the Department's orders, they complained that they could sniff the sewer-gas as they came along the passage, and advised him to set his own house in order before ordering localities to sewer. Perhaps he was not wise in making these remarks; but he was so old, and had got so independent, that if he got a 'wigging' he should not very much care.

Mr. Robins observed that in justice to Sir Gilbert Scott there ought to be some power to control the drains in the lower parts of the new buildings at Whitehall.

The President disclaimed any wish to cast any reflection on Sir Gilbert Scott, but he justified his remarks by giving unsavoury details of the insanitary condition of the buildings in Whitehall. The plans of the sewers of public buildings were under one Department—not his Department—and when he asked for the plans he was told 'to mind his own business.' If the new Government buildings were bad, the basement of Somerset House was far worse. Somerset House was an old building, with an old system of sewerage, and was densely populated, and ill-ventilated. If he had to occupy offices in Somerset House, he would at once throw up his appointment. And as to the great War Office, there was no beggars' common lodging-house in the country fouler, in regard to the condition of the basement; and as the basement was so were the rooms.

Mr. Henry C. Burdett said he wished to make a few remarks from a householder's point of view. He looked on the plan adopted in Memphis with great satisfaction. Every house had a 4-inch ventilator carried above the roof, and this was compulsory. It was also necessary that the plans of every house should be approved. He wished that these rules were the law in England. He believed that they must have compulsory legislation on these points, and if a strong Government on sanitary questions were in power, and carried the necessary measures, it would not be so necessary for the Sanitary Congress to go from town to town. The placing of houses in a sanitary condition should not be a matter of option, but of necessity by law. They had had too much permissive legislation, and they now wanted the power to protect themselves against the carelessness and covetousness of those who lived in their midst.

Mr. Lemon, C.E. (Southampton), pointed out that under existing regulations it was necessary that plans of drainage should be submitted to the local authorities, who had ample powers, though they were too often reluctant to put them in force owing to the pressure put upon them from outside in all directions. He was also of opinion that no system was perfect which dispensed with man-holes. He was happy to say that the separate system was gaining ground, in the view that the rainfall should go to the streams.

Dr. Maclagan, as a Medical Officer of Health, corroborated Mr. Lemon's statement as to plans of drainage having to be approved by the local authorities.

Colonel Jones pointed out that the system used in Memphis was advocated so far back as 1847 by Mr. Chadwick.

Dr. Carpenter took exception to the way in which the sewage of Memphis was disposed of in sending it into the sea. He endorsed the principle laid down :—'The rainfall to the river and the sewage to the soil.' Great Britain could not afford to lose the sewage, whatever America might do, and if it were cast into the sea it must eventually end in bankruptcy. He believed that we could get three times the produce from the land if the sewage were properly utilised, yet it was thrown away because they could see no benefit to themselves from applying it to the land; but this action would make this country to be more and more dependent for food upon the foreigner. He did not think that the towns would ever obtain direct profits from their sewage; but in his opinion it was the person who put it on his land that should get the profit.

Mr. W. White said he believed that at Memphis it was necessary to get rid of the sewage effectually and at once, and that could not have been done if they had looked about for means of utilising it.

Mr. Towle (Oxford) advocated the distribution of sewage over the land, and maintained that it could be pumped to any height. The whole country should be one 'immense sewage farm.'

Mr. Rogers Field (who was called on by the President to reply on behalf of Colonel Waring) was bound to say that he agreed with the President that it would have been better if there had been man-holes on the sewers. At the same time, there were several very special features in this case which altogether took it out of the ordinary category. Not a single old drain or street gully was connected with the sewers, and all the house drains were strictly limited to 4-inch pipes, so that nothing could get into the sewers that could not pass through a 4-inch pipe. All the service and branch sewers were automatically flushed every day by the discharge of the flush tanks.

The ventilation of the sewers was effected by an immense number of ventilating pipes, one of these being carried up every single house. These conditions were altogether unprecedented, and they could, therefore, hardly judge of the works by the rules applicable in ordinary cases. Moreover, the works had to be carried out with extraordinary rapidity, and at the least possible cost, in consequence of the impoverished state of the town.

The PRESIDENT, in his concluding remarks, stated that when he was a younger man, and engaged upon designing works of sewerage, he had not the advantage of the self-acting flush tank used on the Memphis works, otherwise he should certainly have availed himself of it.

A vote of thanks was then accorded to Colonel Waring for sending his paper.

APPENDIX.

REPORT OF THE JUDGES OF THE EXHIBITION HELD AT EXETER, SEPTEMBER AND OCTOBER 1880.

ALPHABETICAL LIST OF FELLOWS OF SANITARY INSTITUTE.

APPENDIX.

REPORT OF THE JUDGES OF THE EXHIBITION.

We, the undersigned, the Judges appointed by the Council, beg leave to recommend to the Council the following distribution of Medals and Certificates.

MEDALS.

We recommend that MEDALS should be awarded to the under-mentioned Exhibitors :—

Carter, John, 6a, *New Cavendish Street, Portland Place, London, W.*, for Invalid Furniture.

Colman and Glendenning, *Chalk Hill Works, Norwich, and* 62, *St. Martin's-le-Grand, London, E.C.*, for School Furniture.

Hunt, N., 43, *City Road, Bristol,* for his Patent System of Auto-pneumatic Ventilation.

Moore, Josiah, *Sekford Works, St. James's Walk, Clerkenwell, London,* for Glass Louvre Ventilators.

Moser, L., *Southampton,* for Dry Closet, suitable for Ashes or Disinfecting Powder.

Sanitary and Economic Supply Association, Limited, *Gloucester,* for Dr. Bond's Patent Euthermic Ventilating Gas Stove.

Tylor J. and Sons, 2, *Newgate Street, London,* for Patent Flushing Rim Lavatory Basin and Apparatus.

Webb, H. Chalk, *Worcester,* for his method of impregnating Wood with colours in patterns.

Wilson Engineering Company, The, *Pear-Tree Street, Goswell Road, London,* for the Wilson Portable Close Cooking Range.

SILVER MEDALS given by the Exeter Gas Company.

Four silver medals were offered by the Exeter Gas Company for the best Gas Stoves exhibited under the following classes :—

1. For the best Gas Stove or gas apparatus for cooking purposes for families, including a sufficient supply of hot water.

2. For the best Gas Cooking Stove for an artisan's family of from four to eight persons.

3. For the best and most economical Open Gas Fire.

4. For the best heating arrangement for general purposes, among

which are included the best methods for heating baths; we recommend that one of these medals be awarded to the

Sanitary and Economic Supply Association, Limited, *Gloucester*, for Dr. Bond's Patent Euthermic Ventilating Gas Stove.

We regret, after careful practical trial, that we cannot award Medals for any of the Gas Cooking Stoves or Bath Heaters.

We refer for further practical trial, Messrs. Verity's Open Gas Stove, exhibited by Messrs. Willey and Co.

CERTIFICATES.

We further recommend that Certificates of Merit be awarded to the undermentioned Exhibitors:—

Bird, P. Hinckes, 1, *Norfolk Square, London, N.W.*, for Large Legible Spirit Thermometer.

Branksea Island Pottery Co. (Limited), *Poole, Dorset*, for Stoneware Pipes.

British Sanitary Company, 205, *Buchanan Street, Glasgow*, for Patent Self-Acting Earth-Closet.

Brock, William, and Co., 177, *Fore Street, Exeter*, for 'Non-Such Adjustable Chair.'

Brock, William, and Co., 177, *Fore Street, Exeter*, for Bed-Rest with Moveable Arms.

Calvert, F. C., and Co., *Bradford, Manchester*, for Improved Vaporizer for Disinfecting.

Candy and Co., *Newton Abbot*, for 'Granite Vitrified' Bricks and Paving.

Chorlton and Dugdale, 19, *Blackfriars Street, Manchester*, for the 'Sunlight' Stove.

* Chorlton and Dugdale, 19, *Blackfriars Street, Manchester*, for Excelsior Patent Spring Mattress.

Chorlton and Dugdale, 19, *Blackfriars Street, Manchester*, for Invalid's Adjustable Bed.

Colman and Glendenning, *Chalk Hill Works, Norwich*, for Patent Automaton Seat for Drapers.

Constantine, T. J., 61, *Fleet Street, London, E.C.*, for the Devonshire Cooking Range.

Craig, J. M., *Kilmarnock, N.B.*, for Buchan's Patent Trap.

* Doulton, H., and Co., *Lambeth, London*, for Patent Antipercussion High Pressure Draw-off Valves.

* Doulton, H., and Co , *Lambeth*, for Stanford's Patent Joints for Stoneware Pipes.

Garton and King, 190, *High Street, Exeter*, for Vowel E. Bradford's Patent Family Washing Machine.

Hancock, F. and C., *Dudley, Worcestershire*, for Dough Kneading Machine.

Hancock, F. and C., *Dudley, Worcestershire*, for New Propeller Churn.

* Lascelles, W., 121, *Bunhill Row, London*, for Concrete Bath in one piece.

*MAIGNEN, P. A., 20 and 23, *Great Tower Street, E.C.*, for Patent Filtre Rapide.

MAIGNEN, 20 and 23, *Great Tower Street*, for 'Bijou' Filtre Rapide.

MCCALLUM, J. B., Borough Surveyor, *Stafford*, for Improved 'Non-Absorbent' Tub or Pail Van.

PARKER, J., *Woodstock, Oxon*, for Dry-Earth Commode without Separator.

PRITCHETT, G. E., 20, *Spring Gardens, London*, for Corrugated Iron Hot Water Warming Appliances.

PRITCHETT, G. E., 20, *Spring Gardens, London*, for Improvements in Thermometrical and Barometrical Instruments.

SALMON, BARNES and Co., *Canal Head Foundry, Ulverston*, for Revolving Shutters with Patent Balance-Weight Motion.

SHARP, C. H., and Co., 104, *Newgate Street, London*, for Ornamental Inlet Ventilators.

SILICATED CARBON FILTER COMPANY, *Battersea*, for Silicated Carbon Double-Chambered Table Filters.

TYLOR, J., and SONS, 2, *Newgate Street, E.C.*, for Improved Enamelled Iron Slop Sink with Patent Regulator Supply Valve.

TYLOR, J., and SONS, 2, *Newgate Street, London, E.C.*, for Patent 'Waste-not' Regulator Valve.

TYLOR, J., and SONS, 2, *Newgate Street, London, E.C.*, for Improved Full Way Stop Valve.

WILLEY and Co., Gas Engineers, *Exeter*, for their exhibit of Gaseliers and Gas Brackets.

*WIPPELL BROS. and ROW, 231 and 232, *High Street, Exeter*, for Moule's Earth Closet.

WIPPELL BROS. and ROW, 231 and 232, *High Street, Exeter*, for Ransome's Artificial Stone Air Brick.

WIPPELL BROS. and ROW, 231 and 232, *High Street, Exeter*, for Conservatory Boiler, with Hot-water Pipes.

WIPPELL BROS. and ROW, 231 and 232, *High Street, Exeter*, for Cottage Range.

WIPPELL BROS. and ROW, 231 and 232, *High Street, Exeter*, for Fenby's Patent 'Paragon' Camp Furniture.

WIPPELL BROS. and ROW, 231 and 232, *High Street, Exeter*, for Chappuis' Daylight Reflector.

WIPPELL BROS. and ROW, 231 and 232, *High Street, Exeter*, for Improved Housemaid's Box with Sifter.

There are two classes of exhibits which we recommend should be excluded from awards of Medals—namely, those which were exhibited at Leamington, Stafford, or Croydon, and to which a Medal was then awarded; some of which we recommend should receive Certificates, and these we have distinguished in the foregoing lists by asterisks; and secondly, objects exhibited or invented by any of the judges themselves, such as Mr. ROGERS FIELD'S Self-Acting Flush Tank and Annular Flushing Syphon, exhibited by Messrs. BOWES, SCOTT & READ, Broadway Chambers, Westminster.

DEFERRED FOR PRACTICAL TRIAL.

Wall Papers.

Woolams W. and Co., 110, *High Street, London, W.*, Paper Hangings Guaranteed Free from Arsenic.

Cotterell Bros., *Clare Street, Bristol*, Non-Arsenical Paper Hangings, and Non-Poisonous Colours.

Machinery.

Crosley Bros., *Great Marlborough Street, Manchester*, Patent Otto Silent Gas Engine.

Water Closets—Valve Closets.

Doulton and Co., *Lambeth, London*, Lambeth Valve Closet.

J. Tylor and Sons, 2, *Newgate Street, London*, Patent 'Clear Way' Regulator Valve Water Closet, with Patent Parallel Pull.

Wash-out Closets.

Doulton and Co., *Lambeth, London*, Flush-out Closet.

Bostel, D. T., 8 *Golden Lane, London*, Brighton Excelsior Closet.

White, William, 30a *Wimpole Street, London*, Patent Water-Closet Flushing Basin with Valveless Waste-preventing Apparatus.

Hopper Closets.

Doulton and Co, *Lambeth, London*, Hopper Closet.

J. Tylor and Sons, 2 *Newgate Street, London*, Seat Action Waste-preventing Cistern Water Closet.

Urinals.

J. Tylor and Sons, 2 *Newgate Street, London*, Patent Wash-out Urinal Basin.

Sewage Treatment.

Stephan, J. A., *Rainbow Hill, Worcester*, Carbonised Iron Stone Mound Filters.

Water Supply Apparatus.

Bean, A. T. and W. J., 22 and 23 *Great Tower Street, London*, Patent Flushing Valve and Waste Preventer, and Patent Direct-acting Valveless Waste Preventer.

Ball Valves.

Tonks, G. T., 62 *Rea Street, Birmingham,* Meakins's Patent Ball Valve.

Willoughby, J., 11 *Seaton Terrace, Mutley, Plymouth,* Ball Taps.

Doulton and Co., *Lambeth, London,* High Pressure Ball Valves.

White, William, 30a *Wimpole Street, London,* Bib Taps and Ball Valves.

Stoves, etc.

Doulton and Co., *Lambeth, London,* Ventilator Tile Stove.

Willey and Co., *Exeter,* Verity's Patent Gas Fire.

R. H. Griffin, 40 and 41 *Kirby Street, Hatton Garden, London,* Patent Ventilating and Heating Register Stoves.

A. Hutchinson and Co., 3 and 4 *Great Winchester Street, London,* India-rubber Gas Tubing.

Foods.

Fry, J. S., and Sons, *Union Street, Bristol,* Specimens of Chocolate and Cocoa.

Filters.

The Sanitary and Economic Supply Association (Limited), *Gloucester,* Dr. Bond's Patent Regulating Filtering Cistern.

Mineral Waters.

Carter and Co., *Old Refinery, Bristol,* Mineral Waters and other Beverages.

G. H. Skinner, 13 *North Street, Exeter,* Mineral Waters and other Beverages.

Disinfectants.

Rimmel, Eugene, 96 *Strand, London,* Ozonised Preparations.

Calvert, F. C., and Co., *Bradford, Manchester,* Carbolic Acid and Preparations of it.

Jeyes and Co., Jeyes' Perfect Purifier.

Simpson, G. D., Seaweed Preparations.

Mackey, Mackey and Co., 2 *Bouverie Street, Fleet Street, London,* Disinfectant Preparations.

Until the deferred trials have been made, we are unable to recommend the award of the Richardson Medal.

(Signed) W. H. Corfield (Chairman).
H. C. Bartlett.
W. Eassie.
Rogers Field.

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